Materials Engineering in Product Design & Manufacture

Materials & Methods

January 1954

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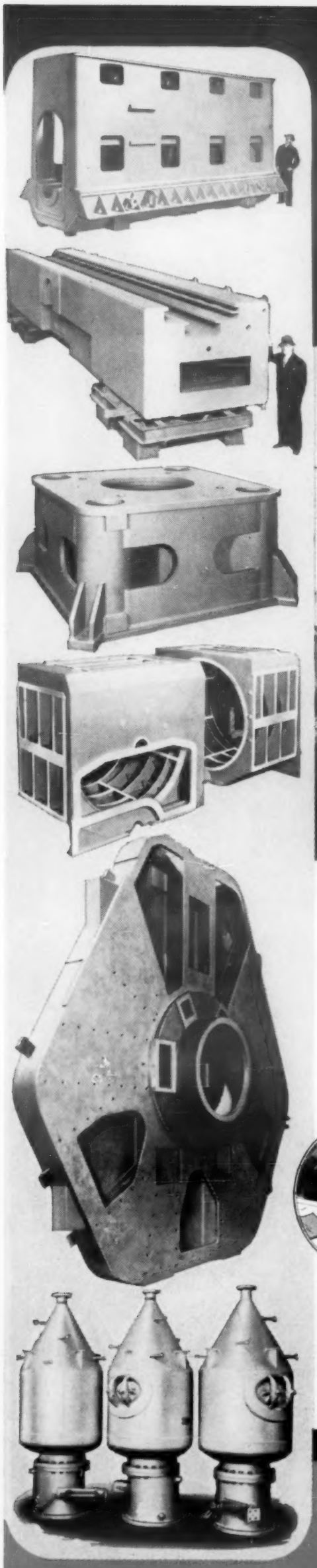
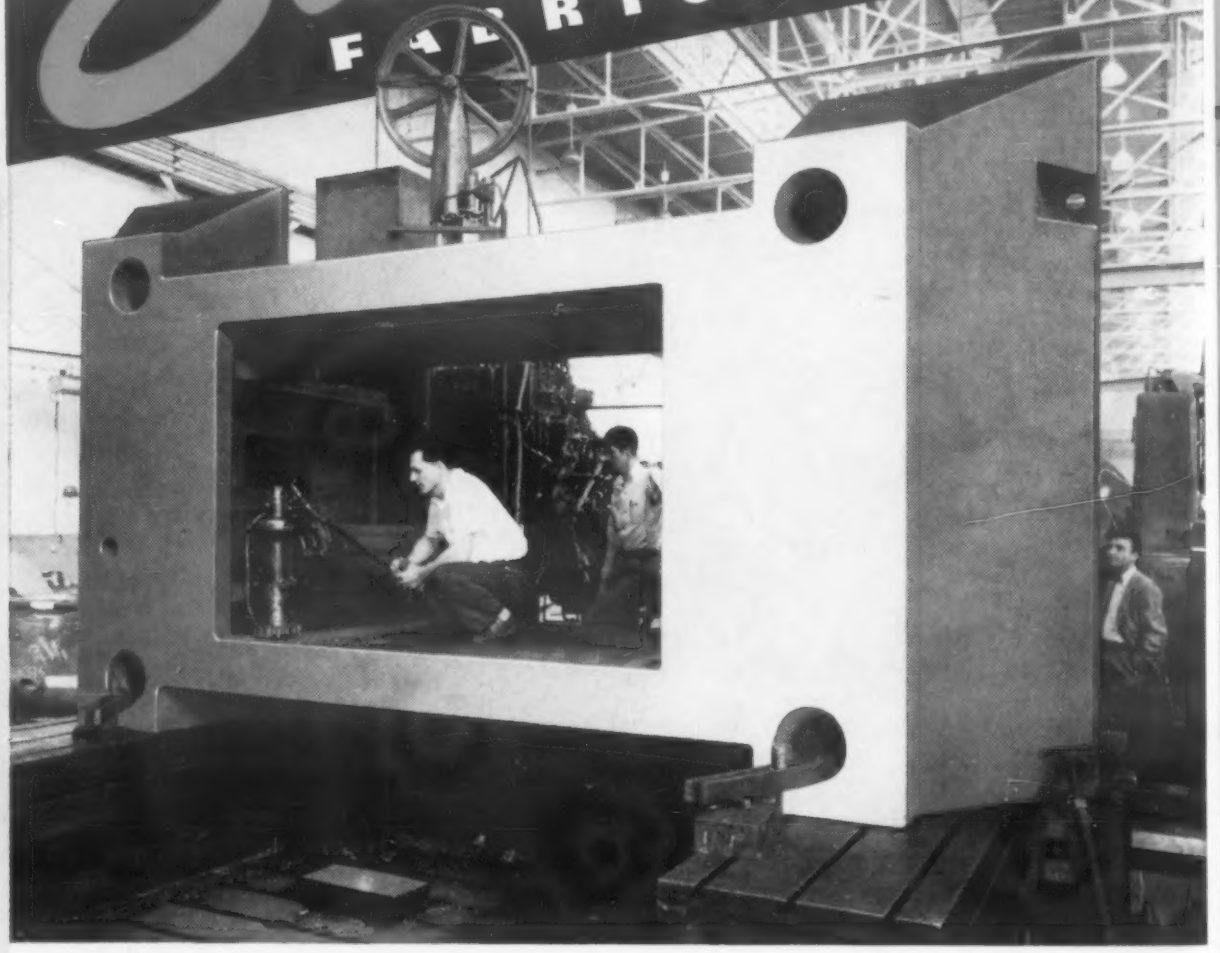


Steel-Weld

FABRICATION



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Materials Engineering in Product Design & Manufacture

Materials & Methods.

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MATERIALS & METHODS IS INDEXED REGULARLY IN THE ENGINEERING INDEX AND THE INDUSTRIAL ARTS INDEX

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Still in good shape

after 2 years of Nicrobrazing

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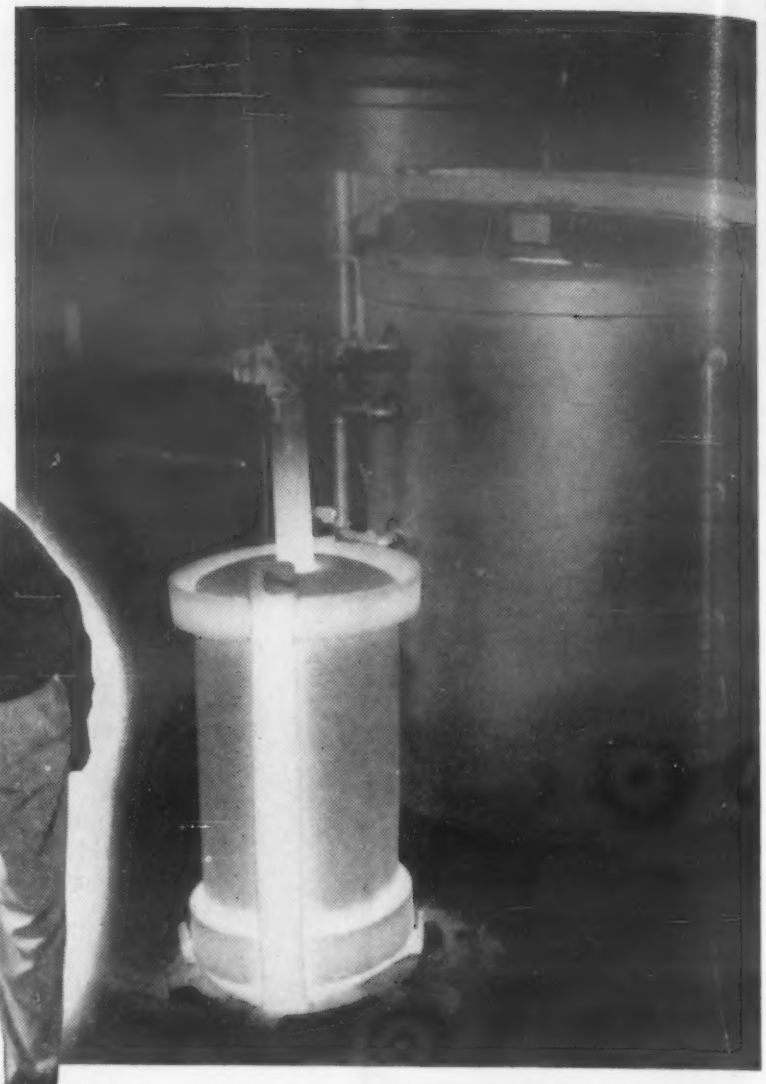
2,150°F.



This Inconel bell retort has just been removed from a Model 24C bell type furnace at the American Gas Furnace Company, Elizabeth, N. J. It had been soaking at a temperature of 2,150°F. Heat-treating jobs at these high temperatures are daily routine at the American Gas Furnace Co.

Parts being loaded on Inconel racks for heat-treating.

At the American Gas Furnace Company, skilled workmen take on heat-treating jobs few other shops would care to handle . . . .

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The Materials Outlook

PLASTIC PIPE ON THE SPOT

In a few months it will be possible to mold reinforced plastic pipe in diameters from 6 to 60 in. or more at the location where it is to be installed. The new patented method makes use of low-cost reinforced plastic molds and the principle underlying centrifugal casting. The method can be adapted to other hollow shapes by simple adjustment of the rotating mechanism.

EXTRUDED STEEL SHAPES

Extruded steel shapes are now being used on two military aircraft. In one case cost savings of 70% per part were realized compared to machining. In the other case, materials savings of more than 60% were achieved. Increased use of extruded steel shapes appears likely as engineers show growing interest in high-strength steel for aircraft components.

TEMPERATURE-INDICATING PAINTS

Navy scientists are developing a series of paints that undergo easily observed color changes at definite temperature levels. So far they can check on temperatures between 120 and 500 F, but the program will eventually be extended to higher temperatures. Like color-changing crayons, these paints are useful for surfaces inaccessible to conventional instruments. The paints are especially useful where a relatively large area is to be checked.

SELF-MACHINABILITY

Recent French work shows that some metals, particularly aluminum alloys, can be machined with cutting tools made of the material being machined. Cutting speeds and surface finish comparable to that obtained with normal hard cutting tools have been achieved. The tool retains a stable cutting shape by virtue of the formation of a durable built-up edge on the tool as soon as cutting starts.

NEW TYPE METAL BELLOWS

A welded-diaphragm type of metallic bellows, originally developed for atomic energy application, is now on the market. The welded-diaphragm construction is claimed to provide greater flexibility and expansion range together with longer service life compared to conventional designs. Both standard and nesting type bellows are produced in stainless steel, Monel and Inconel.

(Continued on page 4)

The Materials Outlook *(continued)*

NEW BEARING ALLOY

A new British bearing alloy, containing 30 copper, 30 silver and 40% lead, appears to offer advantages over many materials now available. Its mechanical properties at elevated temperatures are said to be better than those of the conventional tin-base alloys. In compressive strength it equals the copper-30% lead alloy. Corrosion resistance is believed satisfactory, though not as high as in the tin alloy.

VIBRATION CLEANING

An aircraft company is using a combination of detergent and mechanical vibration to clean complex servo valves. The valves are bolted to plates which are vibrated by a conventional machine, and the detergent is pumped through the valves. This process differs considerably from "ultrasonic cleaning" in that the part, rather than the cleaning solution, is vibrated and the vibrations are of a much lower order of frequency.

COLD WELDING

A tool for the cold lap welding of aluminum and electrical copper sheet is now commercially available. A corresponding tool for the cold butt welding of aluminum and copper wire is expected on the market shortly.

UREA-PHENOLIC MOLDING

Although ureas and high-strength phenolics are generally considered not compatible, they have been combined in a recent molding. Preheated preforms of the two materials are molded together to form a TV tuner knob, shaft and gear. The phenolic is used for the gear section, avoiding the necessity of a brass insert.

LIGHT METALS IN AUTOS

A trend toward increasing use of aluminum and magnesium alloy parts in automobiles has been evident for some time. It was confirmed recently by Chrysler Corp. which announced that its 1954 sedan contains 64 lb of light metals representing a weight saving of about 183 lb. In convertibles, this figure is as high as 225 lb.

TITANIUM CARBIDE

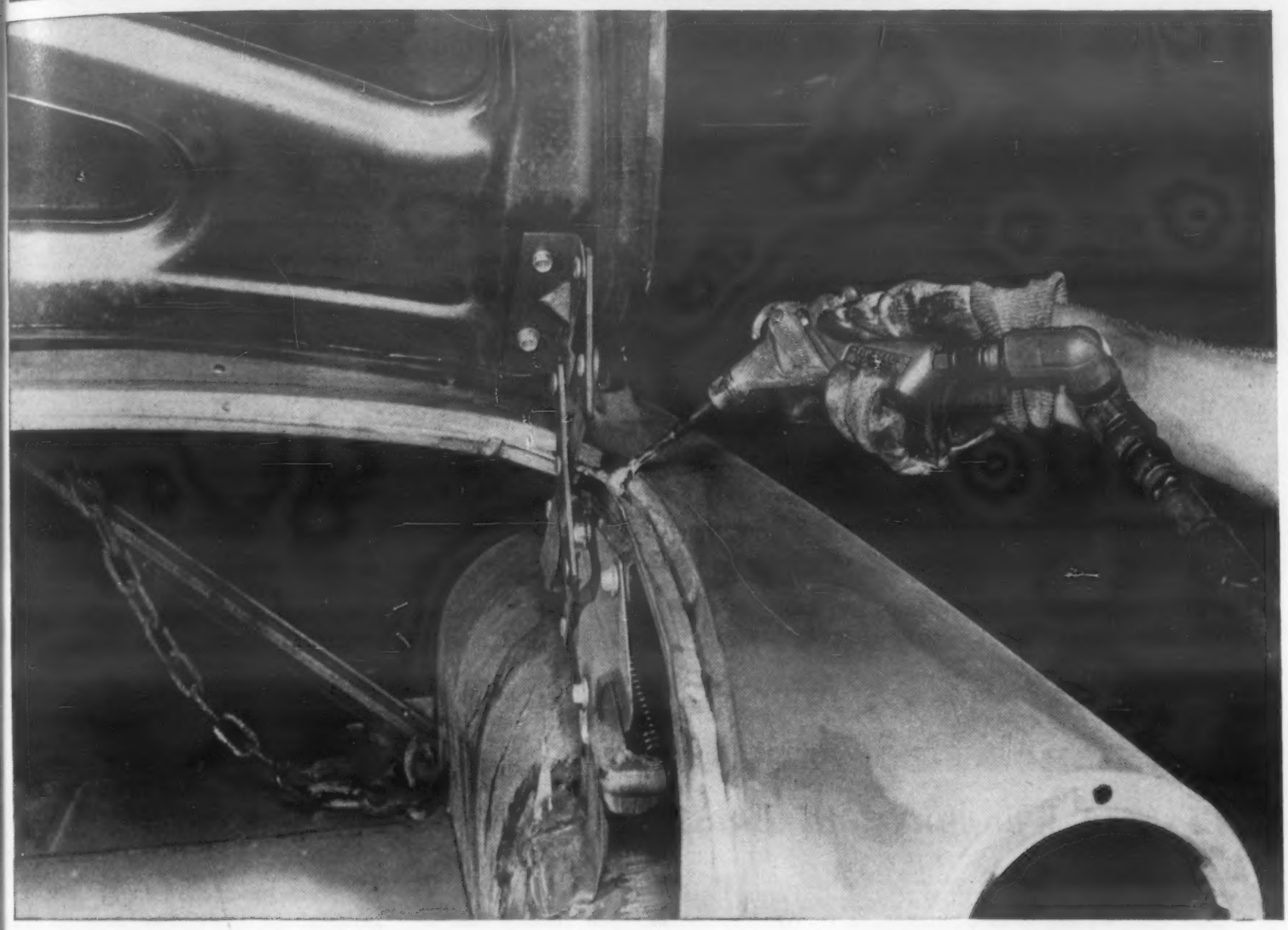
Some of the questions engineers are asking about feasibility of nickel-cemented titanium carbide for structural parts in gas turbines may be answered as a result of tests now being conducted in a specially designed gas turbine operating at temperatures of 2000 F and above. The small radial inward-flow machine was built by the company which has been the chief proponent of this material in order to speed its evaluation for such service.

EVALUATING WELDING ELECTRODES

A large auto manufacturer has set up an extensive program for evaluating the large quantities of welding electrodes purchased for the manual arc welding of frames and body parts. In addition to determining by scientific tests which electrodes are technically most satisfactory for different types of jobs, the program is designed to show which electrodes offer the lowest production costs.

Another new development using

B. F. Goodrich Chemical *raw materials*



B. F. Goodrich Chemical Company does not manufacture this plastic sealant. We make the Geon paste resin only.

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CARS have vital spots where a dependable weather-sealant is a "must". And that's where Geon paste resin does a great protective job!

A plastic compound, made from this resin, is applied with air guns as cars move along the production line. Operators shoot the liquid-like vinyl plastic into the drip-guard rail around the car top, around the windshield frame, and along the trunk where rain, snow or dirt might leak past spot-weld seams into the car.

The easy-flowing plastic compound adheres tightly to the bare metal body. After the car is painted and baked, the sealant is completely fused and will not break off or crack during the life of the car.

This use for Geon paste resin may point out ways to help you improve or develop more saleable products. It can be used in many coating, casting, molding or dipping operations—resists oil, greases and many chemicals. Upholstery, floor mats, trunk linings and electrical parts are only a few products made from Geon. For technical information, please write Dept. GN-1, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

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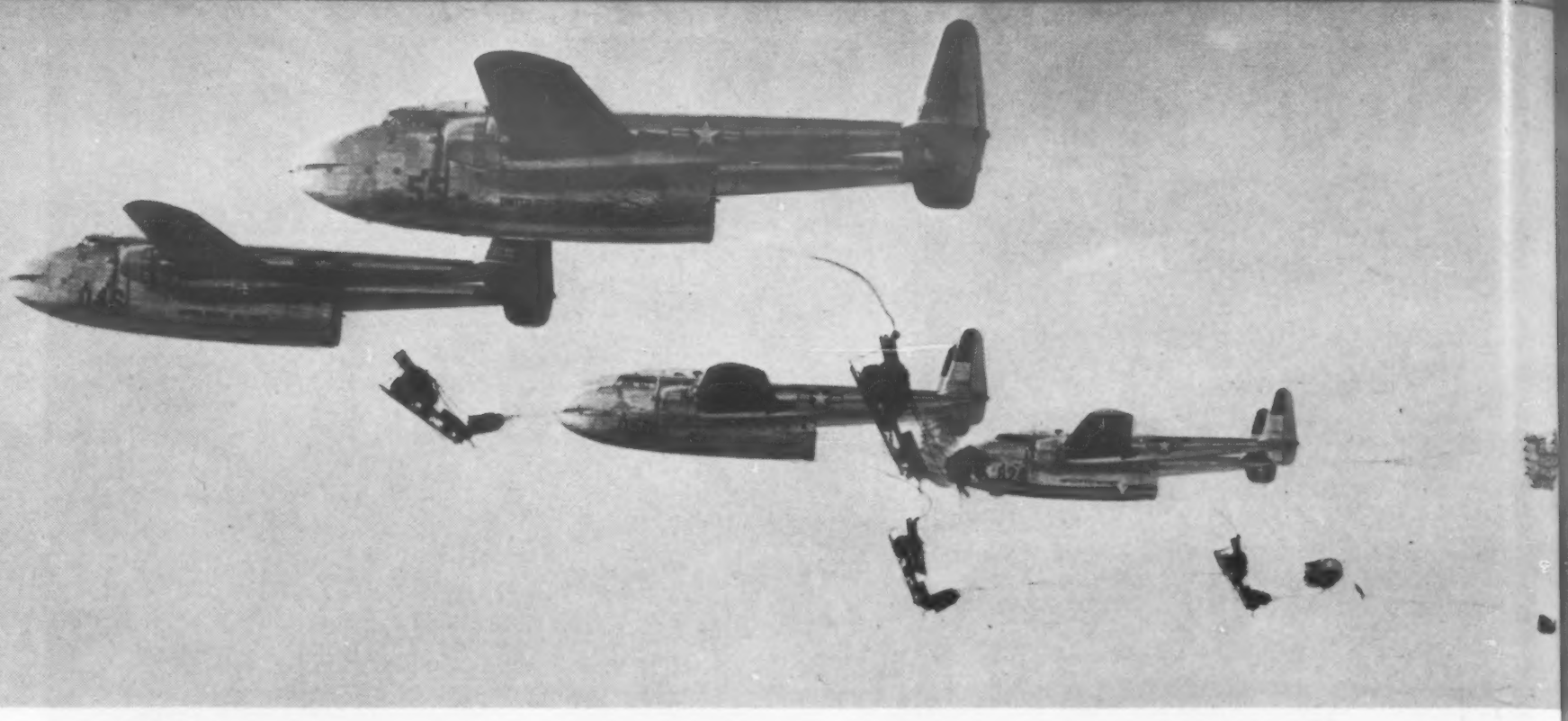

Airlifting heavy weapons and supplies to combat areas proved practical in Korea. Army Ordnance now plans to trim the fat from all equipment to make the whole Army more "airliftable". *Fairchild*

Ordnance Program Calls for Airlift Armies

Lighter Weapons and Equipment Specified in Policy Bulletin

A broad program for lighter and more compact ordnance equipment is outlined for military suppliers in a bulletin released recently over the signature of Major General E. L. Ford, Chief of Ordnance, U. S. Army. The Bulletin reveals that a comprehensive reevaluation of design concepts for ordnance equipment is underway. New materials and application of light and high strength metals will play a more important role in future ordnance procurement.

Behind the program is the vastly increased importance of aircraft as transport and logistic supply carriers for troops in combat areas. As a result of combat experience in Korea, Army Ordnance is growing more critical of extra weight and bulk in all types of military equipment.

Fairchild C 119 packs in a truck, two jeeps, communications equipment and 14 troops, can land in small, rough fields. *Fairchild*

Modern Mobility

Today's concepts of military mobility are as far removed from those of World War II as the mechanized Panzer-Blitzkrieg was from static trench warfare. The helicopter and cargo transport have proved capable of delivering whole armies hundreds and even thousands of miles in a matter of hours. In future actions, all men and equipment, including trucks, heavy and light weapons, communications equipment, and even hospital facilities may have to be delivered and supplied wholly by air. It means, in effect, that the days of overdesigned, superstrong and superheavy gear are numbered.

Johnson's Views

The Ordnance Bulletin quotes Undersecretary of the Army Johnson's views on modern warfare to present the background of the problem facing military equipment design: "The key to our plan must be mobility—fast, dependable, everpresent capacity for mobility which is capable of outstripping enemy intelligence. We need—and dreadfully need—the capacity to deliver relatively powerful forces of men and material rapidly to any part of the world. The concept of battle must be freed from the limitations of mud, mountains, morasses and even roads . . . We must be able to hit our ememy three times for each blow we receive. This . . . in effect increases our relatively limited manpower resources threefold.

"The Army has embarked on a program of lightening the load of the combat infantryman and the weapons and equipment to support him. It is a very important step in making him airliftable. This weight reduction program . . . is being extended to a host of support items, including ammunition, jeeps, large caliber guns, etc.

"The problem of becoming airborne . . . is a considered goal which we must . . . attain. If war should come, an airlift capacity must exist which is . . . transoceanic . . . and capable of lightening assault. It is often said that the next war will be won or lost quickly. If this is true . . . our preparation and planning will have to be reoriented. Preparation and planning based on D plus so many months becomes quite unrealistic. D plus so many days . . . even D plus so many *hours,* may be the correct and crucial basis for planning."

Re-design

Specific recommendations for implementing the design for an airliftable army are outlined in the bulletin. It states, "The production of lighter ordnance material logically starts with research and development. New ideas and ingenious uses of both old and new materials must be developed: redesigning, where sufficient return is possible, and designing to make most efficient use of [materials], must be done. To lighten equipment, further refinement of design by more exact stress analysis must be accomplished; greater use of alloys of aluminum, magnesium, titanium and high strength steels must be made where increased combat effectiveness justifies the increased costs. The success of this program depends on the team of materials engineers and designers of ordnance equipment to whom [the lightening program] should be of special significance."

Light Metals

In reference to aluminum and magnesium the bulletin points out that they should "no longer be regarded as Air-craft Materials". It warns, however, that in order to guarantee sufficient supply of the light metals for an all-out effort, plans to utilize them efficiently must be made *now* in order to test equipment, determine peak requirements, and establish the potential demand.

About 5% of weight of the F 100 Super-Sabre airframe is titanium. J-57 turbojet, capable of pushing the plane over 900 mph at high altitude, also requires large amounts of titanium. Titanium accounts for less than 1% of weight of 650 mph F86 (insert). ***North American Aviation***

Aircraft Manufacturers Reveal Plans to Use More Titanium

Warn Senate Committee of Looming Shortage

As the Senate Strategic Materials Subcommittee hearings on Titanium proceed, testimony from aircraft manufacturers leaves little doubt that they expect a colossal titanium shortage in the near future.

The 1953 harvest of titanium totaled somewhere in the neighborhood of 2000 tons, and new facilities have been slower to come in than anyone predicted. In addition, the variable quality of the titanium alloys produced in many of the current production facilities has resulted in production jams and wasted material.

The government has contracted for titanium facilities capable of producing an annual volume of 12,300 tons the end of this year. ODM has authorized an expansion to 25,000 ton capacity, and at last report the General Services Administration was taking steps to get contracts for the additional amount. However, if past experience is taken into consideration, it will be a matter of years before such new facilities start melting and pouring titanium.

Meanwhile, military aircraft engineers, enthused because of the significant weight savings attainable through the use of titanium, are designing more and more aircraft components to take advantage of the metal's strength and lightness.

North American Aviation reports that its use of titanium has increased from 1% of the gross weight of the F-86 Sabrejet to 5% of the total weight of the F-100 Super Sabre. J. L. Atwood, President of the company, testified before the Senate Commission that projected designs of high performance jet aircraft may call for up to 75% of the structural weight in titanium components.

Other airframe and power plant producers are planning to increase use of titanium in military and civilian aircraft as soon as possible. New designs on the drawing boards will be stressed for the weight and

(Continued on page 198)

News Digest

At Last! A Use for Old Razor Blades

It may not be worth cutting through the wall at the base of the medicine cabinet, but a successful new testing method announced by Ajax Electric Co. uses old razor blades in a nearly fool-proof method for testing the neutrality of salt bath heat treating furnaces.

Frequent testing of the salt bath used in heat treating carbon steels is necessary because exposure to air causes the fused salts to become basic, a condition which decarburizes the surface of the steel under treatment.

The "Used Razor Blade" test is simple and easy, and can be conducted by furnace operators. A blade is immersed in the bath for ten minutes, then given a quick water quench. If the blade breaks when bent, the bath is not decarburizing the steel. If the blade bends, the carbon has been depleted and the bath must be rectified. Partial or complete decarburization can be determined by the relative ductility of the quenched blade, which is fairly obvious after a little experience with the testing method.

Surface decarburization of steel results in a serious loss in surface strength, and can reduce fatigue resistance as much as 40% in combination with surface defects such as pits, scale, and other notch effects. Work immersed in the salt bath is sealed off from oxidation by air, and as the part is coated by a film of molten salt when it is removed from the bath, it is also protected from atmospheric decarburization en route to the quenching medium.

Conventional tests for decarburization in salt baths such as fracture, chemical analysis and file tests are time consuming and usually require special equipment or laboratory technicians. The razor blade tests saves a lot of time and material, and because of the thinness of the blade and its extreme sensitivity to decarburization, the test is reported to be highly accurate.

However, even if the method is adopted universally, it still looks as if the vast majority of used blades will continue to be used in the usual way—to fill the hole in the wall behind the shaving mirror.

Old Textile Fiber Stages Comeback

Use of Ramie Increases

Ramie, the strongest natural textile fiber, is about to get another shot at the American textile market. Recent increases in ramie acreage in Florida and the first large scale commercial production of ramie textile materials in the U. S. indicate that the fiber may be assuming a position of increasing importance in the industrial and consumer fabric and fiber field.

Ramie is a bast fiber. Like other bast fibers, among which are hemp, jute, flax and nettle, it is obtained from the stalk of a plant. In the past, the difficult process of separating the fibers from the gummy waxes and resins of the ramie plant has prevented commercial exploitation of the fiber in the U. S.

Physical Properties

The physical properties of ramie make it a tempting gamble. It is the strongest natural fiber, and among common textile fibers used today, it is exceeded only by nylon in tensile strength. Ramie resists rot and mildew, and is unaffected by water although it is highly absorbent. In this respect it has better properties than many synthetic fibers, which are unabsorbent and difficult to dye. Ramie fiber is the least lignified and purest cellulose of all bast fibers. It has a linen-like lustre, and in its natural state is exceptionally white, being comparable to bleached cotton. The individual ramie fibers are up to 10 in. long, and are flat and untwisted with diameters ranging from 30 to 70 microns. The breaking strength of an individual fiber, if carefully degummed to avoid brittleness, is as high as 35 to 40 gm. By comparison the strength of hemp fibers is only 5 gm. Ramie is affected less by moisture than any other vegetable fiber.

(Continued on page 206)

What They Said . . . . . .

SCIENCE AND RESOURCES "Material science has the clear possibility and promise of the systematic utilization of all the natural resources of the earth for the good of the whole human race. I am sure that maintaining and improving the standard of living for all the peoples of the earth through increasing the use of mechanical horsepower and the scientific approach is now one of the keys to peace in the world."—*C. E. Wilson, Secretary of Defense.*

THIRD DIMENSION "It is technology that gives us the extra things that count . . . We have now opened up a whole new stage for our national development, a stage on which the elements of the land and the people are augmented by a third dimension —the dimension of science."—*Henry B. du Pont, Vice President, du Pont Co., Oct. 1953.*

POWER "It is perhaps unfortunate that nuclear energy has been popularized as a potential source of low cost power. A more rational view is that we have moved a short distance towards a new and perhaps economically feasible fuel source for power production."—*C. C. Whelchel, Pacific Gas & Electric Co., Dec. 1953.*

Materials BRIEFS

Semantics The AIME Powder Metallurgy Committee has appointed a task group to collect data identifying what is meant by "green" strength and to propose methods for its determination.

For Detail Ultra fine grain industrial x-ray film has been developed by du Pont for applications requiring minute detail. Known as type 510, the film can be used with low voltage equipment for examining low opacity materials or with million volt or betatron equipment for examining steel up to three inches thick.

Strikes Twice Both man-made and natural lightning will be used to test insulation materials in a new high voltage lab at Cornell University. Lightning masts will pick up atmospheric electricity and generators will be able to produce enough juice to test almost any insulator to destruction. The windowless building is completely shielded to eliminate local radio interference.

Wheels of Progress Thirty out of thirty three racing cars entered in the last Indianapolis '500' had magnesium wheels. In addition to magnesium wheels, the winning car had magnesium brake and rear end housings and was one of the lightest at the track, tipping the scales at a mere 1623 lb.

No Cold Shakes Vibration isolators of silicone rubber will function at temperatures as low as 100 F below zero. Provision must be made in the design for the greater effect of static strain on the dynamic modulus of silicone if the material is substituted for natural rubber shock mounts.

Steel Wheels Long range cost analyses show that one-wear wrought steel freight car wheels are more economical than chilled iron wheels. Steel will give 17 years of service compared to a 7 year life for the iron wheels.

Tapered Extrusions Work is underway on split dies for heavy presses that enable the size of the die orifice to be varied during the extrusion process in order to produce tapered aluminum extrusions.

Men of Materials . . .

and what they have to say about the needs, development and proper use of engineering materials in modern industry.

CLYDE WILLIAMS
OF BATTELLE

American industry owes much to basic research for its giant strides in the past few decades. Clyde Williams, as president and director of Battelle Memorial Institute, the country's largest independent industrial research organization, has been in a position to observe and guide the seven-league-boots of technological progress. He has been active in governmental, academic and industrial positions that have given him a perspective on industry and science privileged to few men. In the engineering materials field he has served in such positions as: Chairman of the Materials and Metals Panel of the Research and Development Board; Member of the Advisory Committee on Raw Materials, U. S. Atomic Energy Commission; participant in the Scientific Conference on the Conservation and Utilization of Resources; and member of the Minerals and Metallurical Advisory Board of the National Academy of Sciences, to name but a few.

The breadth of his experience and the quality of his leadership in dealing with the relationship of research to industry is well reflected in what he has to say to materials producers on *use* research:

"One of the best ways for a materials producing company to grow and prosper is to maintain a constant program of research aimed at finding new uses for its products. One needs but enumerate some of the most successful corporations today to realize how true this is. The 'big names' in the materials field are invariably companies that have continually sought new uses for the goods they produce.

"*Use* research has been particularly effective in enabling the plastics, glass, petroleum, steel, and aluminum industries to reach their present positions in our economy.

"In times of great demand for materials there is a tendency for producers to neglect *use* research and devote all their efforts to production research. As much as production research is needed, to concentrate upon it at the expense of *use* research is a dangerous practice. Industrial consumers are most likely to be concentrating their efforts on *conservation* research—trying to find ways to reduce the amount of the material in their products or to find substitutes. If the consumer's conservation and substitution research is successful, a market may be reduced or lost. Unless this loss is counterbalanced by new uses for the material developed through the producer's *use* research the material may lose its economic importance.

"The goal, then, of any company in the materials field should be to make its use research more effective than its customer's conservation and substitution research. This is a realistic way to meet competition and to achieve continuing growth.

"Sometimes companies faced with competition and shrinking markets see the hazards ahead of them, but fail to see the opportunities. Preoccupied with how to hold slipping markets, they neglect chances to develop their materials to meet the needs of new markets.

"In this respect, the large central laboratories of industries and research institutes can be very helpful. Working in many phases of science these laboratories frequently foresee potentialities for materials while they are still obscured to producers."

We are happy to join these three you to support the Second Basic

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Dow Corning Corp.
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—One Point of View

A Rebirth

It has been several years now since Materials & Methods devoted space to editorial comment. Abolishment of editorials was done in the mistaken belief that engineers were too busy to read material that was strictly opinion. We have since changed our minds, hence the rebirth of an editorial page which will occupy this space in months to come.

Whether or not engineers and other technical personnel feel they have time to read opinions pertinent to their work, we feel they should make the time. We feel that many men in the fields we serve are so immersed in their day-to-day tasks that they neglect matters which might be of even greater concern in the overall scheme of things.

Take, for example, professional development. Some years ago we were asked to speak on that general subject before a technical group. We recommended that the audience adopt hobbies, dabble in politics, do extensive reading and even do some writing and speaking. No mention was made of anything technical. The entire talk was made to get across the point that technical competence alone was not enough to justify professional progress. When the inevitable question period arrived, we expected a barrage of questions which would serve to elaborate on the suggestions made. Instead, every question was technical and completely brushed aside the general premise of the talk.

Perhaps the fault was the speaker's or possibly this was an exceptional group. We suspect, though, that there was nothing unusual about the affair. We believe the incident further demonstrates that people in this group tend to become overdeveloped in their specialty and badly underdeveloped in the areas which could help them progress.

We don't intend to lecture on this page; all we hope to do is to stimulate thought. If we succeed, the time, effort and space will have been well spent.

Semantics

Engineering is supposed to be precise—a science, rather than an art. Thus it is regrettable that certain products of the engineer's brain have fallen into the hands of people who prefer a glamorous word or phrase rather than that designation which might be less glamorous but more accurate.

In recent years we have heard and talked a great deal about the use of sound frequencies higher than those audible to the human ear. We are told that most of us can discern sounds at frequencies up to 20,000 cycles per second. To designate the inaudible frequencies, the term "ultrasonic" is used. Now comes a promoter with equipment which operates at 10,000 cycles per sec and calls it ultrasonic.

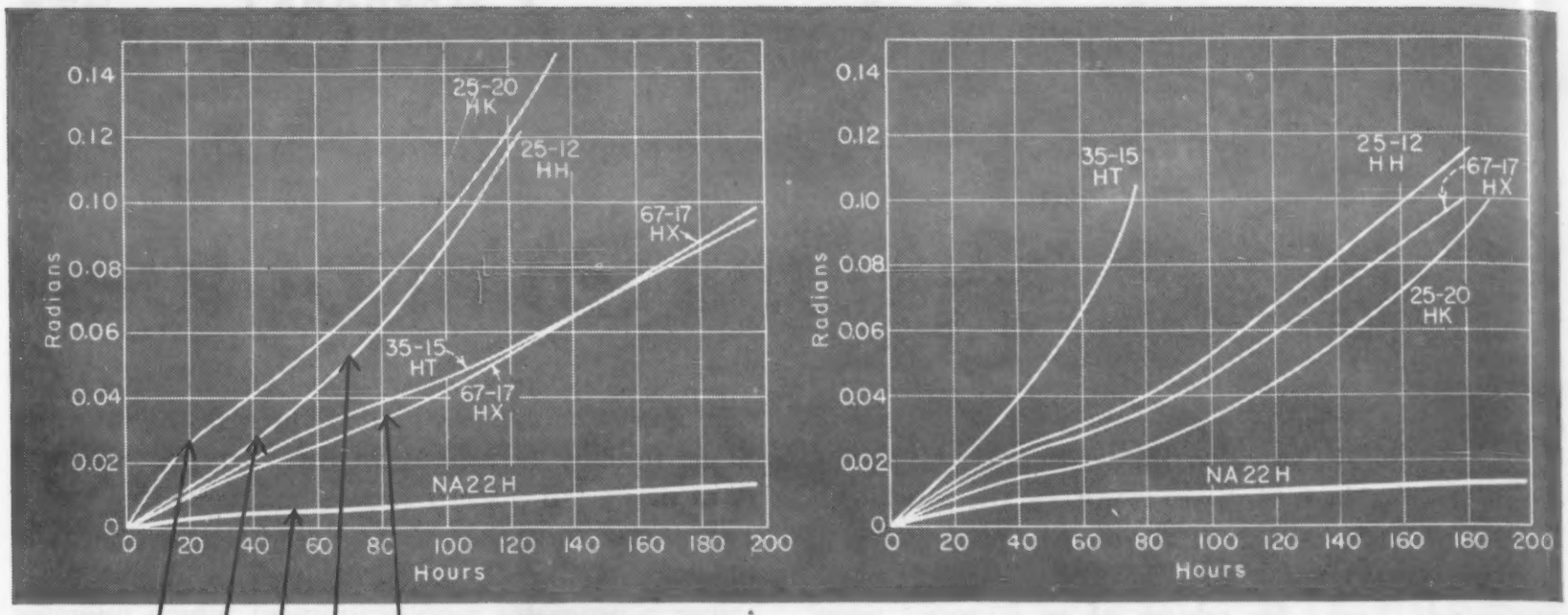
It becomes more than a mere matter of using one word over another. Ultrasonic waves have definite advantages for certain tasks. To lead a potential user to believe that he is getting something and actually giving him something less is fraud.

To us it seems that the engineer should demand the same integrity in the sale and description of the products he develops as he puts into engineering the product itself.

Science and Politics

We notice that a committee of eminent scientists has upheld the integrity of the National Bureau of Standards against charges of improper evaluation of a battery additive. We have a good deal of respect for NBS and were therefore gratified, but hardly surprised at the verdict. Unfortunately, the credence given to these unfounded charges by the Secretary of Commerce has caused more damage than even an apology—which has not been forthcoming—could repair. Scientists cannot work effectively in an atmosphere of distrust and insecurity. The American people have every right to be assured that NBS is performing its job impartially. But it would be well for both our elected and non-elected representatives in Washington to learn that a full investigation should precede, not follow, the charges. Also a committee of independent and highly competent scientists is a more adequate investigating body to probe the affairs of a group such as the NBS than the average assortment of politicians. Politics seems to be a necessary part of our life, but it should stick to its knitting. Politics should be removed from science, although more scientific integrity in politics might be for the better.

J. C. DuMond



Time-deformation curves for cantilever beam test at 2000 F and 1750 psi.

Cantilever beam test (at 2200 F and 500 psi) and time-deformation curves derived from it demonstrate superiority of NA22H over other alloys.

These Curves Show Strength of . . .

New Heat Resistant Alloy

Improved structural stability and resistance to oxidation make this nickel-chromium-iron alloy suitable for service to 2200 F.

● BLAW-KNOX COMPANY has developed an alloy that permits practical engineering use at temperatures up to 2200 F. This is 200 F above the previous design limit for heat resistant alloys. Actual test installations since 1947 have proved the value of this new casting alloy for such applications as radiant tubes, retorts, muffies and similar parts.

At elevated temperatures, many alloys that have strength lack oxidation resistance. Other alloys, that have excellent oxidation resistance, have little strength. Thus, some super alloys have excellent strength up to 1900 F, but none has desirable creep strength above that temperature.

The problem in developing an alloy for temperatures from 2000-2300 F was twofold: 1) to strengthen the nickel-chromium-iron base alloys, and 2) to develop oxidation resistance in conjunction with the strengthening elements. After testing thousands of formulations, an alloy was developed, that showed promise.

This alloy, NA22H, which is patented both in the United States and abroad, has the following nominal composition: 0.50 carbon, 48 nickel, 28 chromium and 5% tungsten. Complete engineering properties have been evaluated in stress rupture and standard tensile creep tests. Comparative properties of this alloy and other commercial heat resistant alloys are given in accompanying tables.

In addition to cantilever tests, free bend, tensile strength, thermal expansion, oxidation resistance under varying atmospheres, tensile creep,

NA22H has shown excellent service life in radiant tube installations.

by M. N. ORNITZ, Works Manager, and R. H. ENGLISH,

Chief Metallurgist, Blaw-Knox Co., National Alloy Division

stress rupture, and thermal fatigue were run on the new alloy in comparison with other heat resistant alloys.

Weldability

NA22H has excellent welding characteristics. Cast rods of this same analysis are coated with special low hydrogen coating and welded with direct current reversed polarity. In welding the standard thin walled (3/8 in. or less) cast forms, no preheat is necessary. The same technique is used as that used with standard commercial heat resisting alloys. In welding heavier sections, a low heat input and frequent stress relieving by peening is advisable, especially for extremely intricate shapes. Laboratory and field tests have shown the welds to be equal to the cast alloy in high temperature properties.

To test the new alloy under actual operating conditions a number of mill installations were made, the first in 1947. The history of a few of the older installations follows.

Radiant Tubes

One of the first applications was in a continuous furnace for the annealing of strip at high temperatures. Forty-four radiant tube assemblies were installed in February 1947. The majority of the original tubes are still in service after 6 3/4 years of continuous operation. The average tube operating temperature has been 2000 F; at intervals the tubes are operated at 2250 F with a product temperature of 2100 F. In all cases where replacement was necessary, it was due to support failure, burner failure, or some other mechanical detail. In no case was a tube removed due to failure of the alloy. Several of the tubes operated for at least eight months without support at the return bend end of the assembly. After this severe service, there was a slight sag in only two of these tubes.

In a continuous tube annealing furnace operating at a temperature of 1800 F the average life of the heating tubes, made of 25 chromium-12 nickel was 17 months. In some sections of the furnace the life was only nine months. The average life of NA22H tubes installed in the most severe locations is 40 months. With the exception of one tube they are still in operation. The oldest NA22H tubes have been in use for at least 59 months in a position which required a new 25 chromium-12 nickel tube every 13 months.

Radiant tubes made of NA22H

How the Development Work was Done

Because of the large number of samples which had to be tested, it was necessary to develop a new, reproducible, and inexpensive procedure for comparing the creep and oxidation resistance of a number of different alloys at the same time, at temperatures up to 2300 F. This was achieved in 1942 when National Alloy developed the cantilever beam test method.

In the cantilever beam test, one end of the test bar (11 in. long by ½ in. in dia.) is fastened securely in an angle-shaped fixture as a simple cantilevered beam. Heat resistant weights are added to the free end of the bar to vary the stress as desired.

The test holder and specimens are placed in a gas-fired muffle furnace which can hold the temperature within 2 F up to 2400 F. After the test bars reach the desired temperature, readings are periodically taken of the deflection of the free end of the bars. A traveling microscope capable of measuring to 0.0001 in. is used.

A plot is made of the angle of deflection in radians against time. The resulting curve is similar to that obtained in the standard type of tensile-creep test.

Table 1—As-Cast Mechanical Properties of Various Heat-Resistant Alloys

Material and Temp.	Tensile Strength, psi	Red. of area, %	Elong., %
Room Temperature			
NA22H	64,500	2.7	3.5
35 Ni-15 Cr (HT)	68,000	10.0	10.0
25 Cr-20 Ni (HK)	71,750		16.0
25 Cr-12 Ni (HH)	75,000	25.0	20.0
1600 F			
NA22H	29,500	37.9	26.5
35 Ni-15 Cr (HT)	18,500	36.0	28.0
25 Cr-20 Ni (HK)	20,000	25.1	11.0
25 Cr-12 Ni (HH)	18,000	28.8	23.5
1800 F			
NA22H	18,000	48.0	32.0
35 Ni-15 Cr (HT)	11,300	26.0	27.0
25 Cr-20 Ni (HK)	10,600	17.4	24.0
25 Cr-12 Ni (HH)	10,000	50.3	45.0

Table 2—High Temperature Properties of Various Heat-Resistant Alloys

Temp., F	NA22H	35 Ni-15 Cr	25 Cr-20 Ni	25 Cr-12 Ni
Limiting Stress for Min Creep Rate of 0.0001% per hr (1% in 10,000 hr), Psi				
1800	2300	2100	2200	1800
1900	1500	1050	1350	—
2000	1050	450	700	700
2100	450	—	230	—
2200	250	—	—	—
Stress to Produce 100 hr Rupture Life, Psi				
1800	5200	4600	4200	4000
1900	3800	—	2850	—
2000	2800	1800	2200	1800
2100	2100	—	900	—
2200	1000	—	—	—
Stress to Produce 1000 hr Rupture Life, Psi				
1800	3600	3200	2700	3000
1900	2350	—	1800	—
2000	1670	—	1100	1000
2100	820	—	520	—
2200	500	—	—	—
Thermal Expansion Coefficients—Millionths of an in. Per in. Per F				
100–800	7.92	8.6	9.0	9.6
100–1600	8.61	9.3	9.7	10.3
100–1800	8.75	9.5	10.0	10.5

are now being used in a continuous strip processing line. In this process a factor limiting the output is the rate at which the strip can be heated, which is a function of the furnace temperature. The furnace temperature is in turn limited by the heat resisting characteristics of the commercial radiant tubes. Tubes, made of 25 chromium-12 nickel alloy, lasted from four to six months in the hottest zone of the furnace. In 1950, NA22H tubes were substituted for the 25 chromium-12 nickel tubes. These tubes are still in use while the tube temperature has been increased from 1800 to 2100 F. Raising the furnace temperature has made it necessary to replace the support shafts, made of 35 nickel-15 chromium, with shafts made of NA22H. Because of the greater strength of the NA22H, the support rolls made of it are less expensive than those made of 35 nickel-15 chromium.

Retorts

The use of retorts made of NA22H has increased the output of endothermic gas generators by as much as 60%. Previously these generators operated at a temperature of 1850 F. With the new alloy these generators now operate at temperatures of 2050 to 2100 F. In addition to the increased capacity, the higher operating temperatures produce a more uniform gas. The life of the NA22H retorts at 2050 F exceeds that of the previously used 35 nickel-15 chromium at 1850 F.

Muffles and Fan

A variety of muffle application

Muffles for the hardening of tool steels in protective atmospheres have been in continuous service for a number of years at temperatures above 2000 F.

has been installed, substituting NA22H for various alloys such as 67 nickel-17 chromium and 35 nickel-15 chromium as well as silicon carbide. These muffle furnaces are used for heat treating a wide variety of items such as sintered carbide, die steels, tool steels, and stainless steel in a protective atmosphere at temperatures of 1900 to 2200 F.

One of the first applications was that of a cover operating at a temperature of 2100 F and installed in 1948. These covers are still in service after extensive use. Muffles installed several years ago have been performing satisfactorily at temperatures of 2000 F and over.

Definite operating data are available on some muffle installations. The history of one of these follows. A muffle, 22 in. wide by 36 in. deep by 14 in. high, was put in operation in September 1950. The furnace is used for heat treating dies; molybdenum, high speed and tungsten tool steels; hot work steels; high carbon, high chromium tool steels; high manganese die steels; and shock resisting steels. This muffle gave excellent service for three years of nearly continuous service at temperatures of 2150 F. The only down time was for holidays. Silicon carbide muffles have lasted a maximum of 4 months in similar service.

A novel application is the use of a cast NA22H high temperature, high speed recirculating fan in a closed muffle furnace. Although the fan operates at a temperature of 2200 F under a stress of 150 psi, it has been in service since 1949.

Electric Heater Supports

One of the earlier high temperature processes carried out in continuous furnaces was copper brazing of steel. This is done in a neutral atmosphere at a temperature of 2050 F. The furnace temperature is 2100 F or higher. Most continuous brazing furnaces are heated with electric heating elements. In a particular furnace, the roof heating elements were supported on 35 nickel-15 chromium alloy beams spanning the furnace. As there was only a very limited space between the bottom of the beams and the top of the work passing through the furnace, only slight sagging of the beams could be tolerated. In a short time, 35 nickel-15 chromium proved inadequate. The space limitations made redesign impossible. Many alloys were tried, including 25 chromium-20 nickel, but the thermal shock caused by cold work passing under the beams was too severe for them. However, NA22H proved satisfactory and it was found that when warpage became too great, the beams could be straightened and reinstalled in the furnace with satisfactory results.

Baffle Support Bars

Another similar installation was the use of NA22H for the support bars of the baffles in a steam superheater. Previously bars made of such heat resisting alloys as 25 chromium-12 nickel and 25 chromium-20 nickel were sagging so badly after three months that shifting of the baffles resulted. In 1948, NA22H bars were substituted. These bars are still in excellent condition.

Other Applications

This alloy is finding other applications. Soaking pit burners are giving good service after approximately two years. Pier caps and rails in a rotary furnace are in excellent condition after five years. More recent uses for NA22H are as roller rails, trays, work supports, and hearth plates.

In an interesting application, the alloy is used for the base plate casting and press arbor for bonding of precious metals to base metals. The products from this furnace are being used in the jewelry and electric industries.

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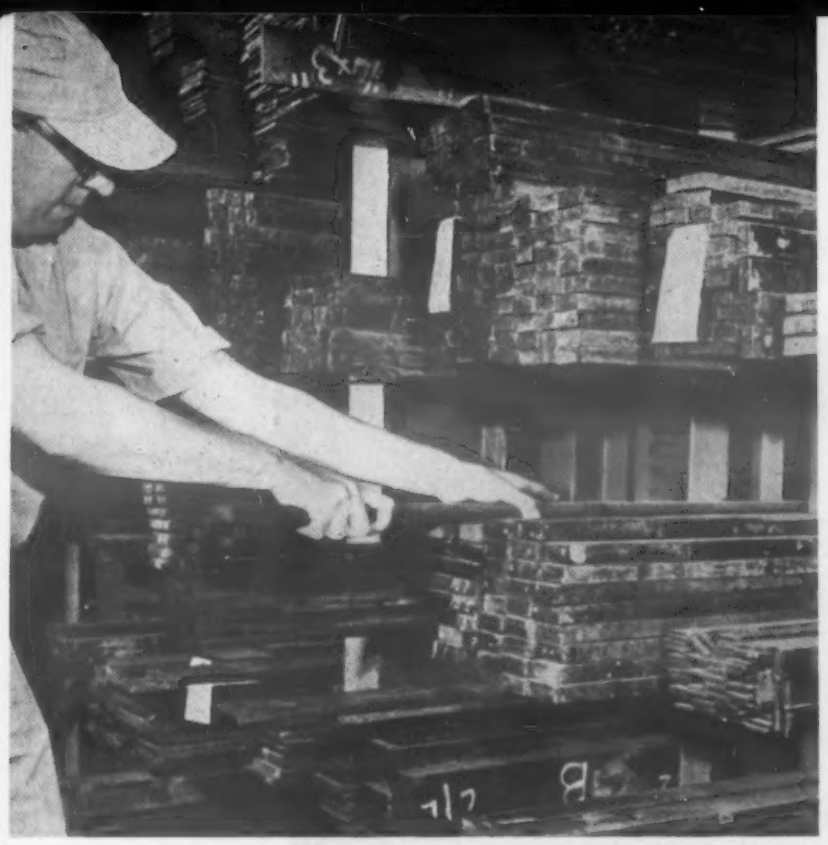
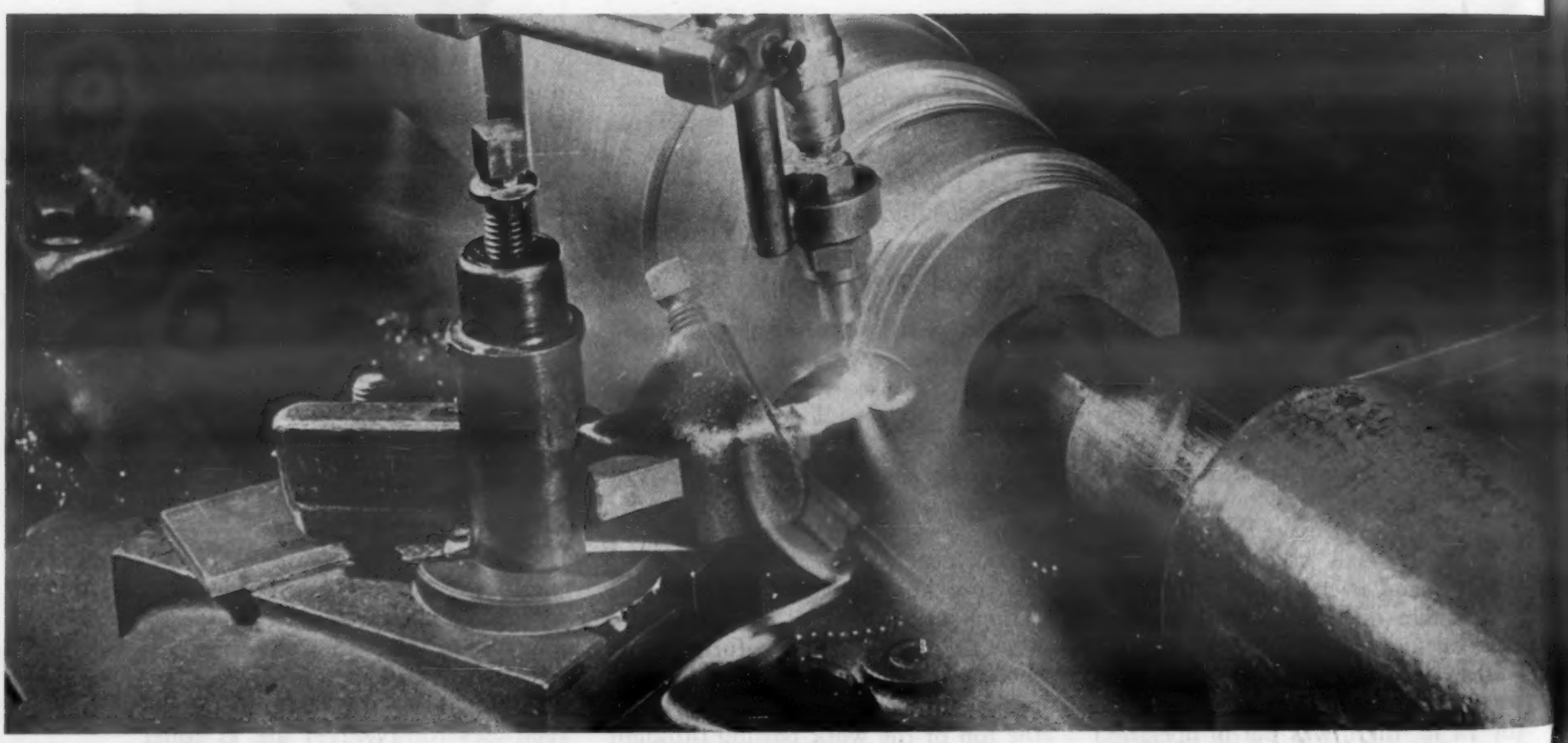


For best results pick a clean steel that hardens to at least 90% martensite.

Thorough soak at temperature and full quench makes for most machinable structure.

1. Select Proper Steel

2. Choose Correct Heat Treatment



Properly ground tools, rigid set-up help simplify machining problems.

3. Use Suitable Machining Conditions for Optimum Machinability of Heat-Treated Steel

by **ROBERT C. GIBBONS**, Chief Metallurgist, Utica Div., Bendix Aviation Corp.

● IN PROCESSING STEEL PARTS that require hardening by heat treating the preferred practice is to machine first and heat treat afterwards; but in many cases the tolerances on finished parts require machining operations to be done after the heat treating has been completed.

Those who have never had experience with the machining of steels in the quenched and tempered condition are apprehensive about doing such work. Many that have had such experience have encountered difficulties that have been discouraging.

Actually the machining of heat-treated steel has been done for many years, is quite well understood in most machine shops and normally presents very few problems. To maintain such a program without difficulties requires thorough understanding and control, not only of the machining operation itself but of all conditions leading up to it. The general practice that should be followed and the conditions that should be watched are enumerated and discussed.

Selection of Steel

Select a steel that will harden uniformly and completely, at least in the area to be machined. Specifically, select a steel that will harden to at least 90% martensite on the quench.

Select a clean steel, relatively free from slag and oxide inclusions. The deleterious effect of inclusions on tool wear is greater in heat treated steels than in annealed steel.

Avoid banded structures, either ferrite banded types or types consisting of free cementite bands. They heat treat to give streaks of hard and soft areas which are more difficult to machine.

Providing the hardenability is satisfactory, the composition is of secondary importance. High carbon content, hypereutectoid types, tend towards carbide banding in which case machining troubles occur. Steels containing nickel-molybdenum combinations seem to machine more readily in the hardened condition than those without these alloys. Free machining steels of the sulfide type are slightly better than the non-free machining types although the value of the extra sulfur diminishes at the higher hardness levels. Leaded steels are reported to be definitely easier to machine at all hardness levels.

Heat Treatment

Steels to be machined after heat treating should be given a full soak at the heat-treating temperature before quenching, should be quenched to full martensite structure and should be fully tempered.

The thorough soak at temperature is to permit complete solution of the carbides and to permit diffusion to even out any banded condition that might be present in the steel. This produces a steel of uniform hardness, free from areas of varying structures.

The full quench is to prevent ferrite from separating out on cooling. A mixture of martensite and ferrite may have a relatively low hardness but is extremely difficult to machine, since the structure consists of alternately very hard and very soft grains. Even after tempering to the specified hardness it will not machine easily. Normal practice in the heat-treating department is to check representative samples of each lot as quenched to determine that the part has been fully hardened. This can usually be done by a hardness test. This does not imply that austempered or martempered parts machine less readily. It implies only that quenching must be rapid enough to insure against ferrite separation, or similar mixed structures.

Full tempering is necessary to break up any hardened structure which might leave hard spots. In the deeper hardening steels, such as AISI 4340, the austenite is sometimes resistant to tempering, especially if the steel has been quenched from a high temperature. In such cases a double tempering may be necessary with the second tempering treatment about 25 F lower than the first. In general, one hour at heat during tempering should be considered a minimum for most alloy steels with increased length of time recommended for deep hardening steels and also for steels tempered below 800 F.

The most desirable structure for machining of heat-treated steels is a uniform tempered martensite structure, free from ferrite, free cementite, banding, and hard non-metallic inclusions. Martensite is generally considered to be too hard to be machinable. This is not necessarily so since low carbon martensite is not very hard. Actually a 100% martensite structure of AISI 8615 steel at 38 Rockwell C machines almost exactly like a tempered martensite of AISI 8640 at the same hardness.

Suggestions for Machining

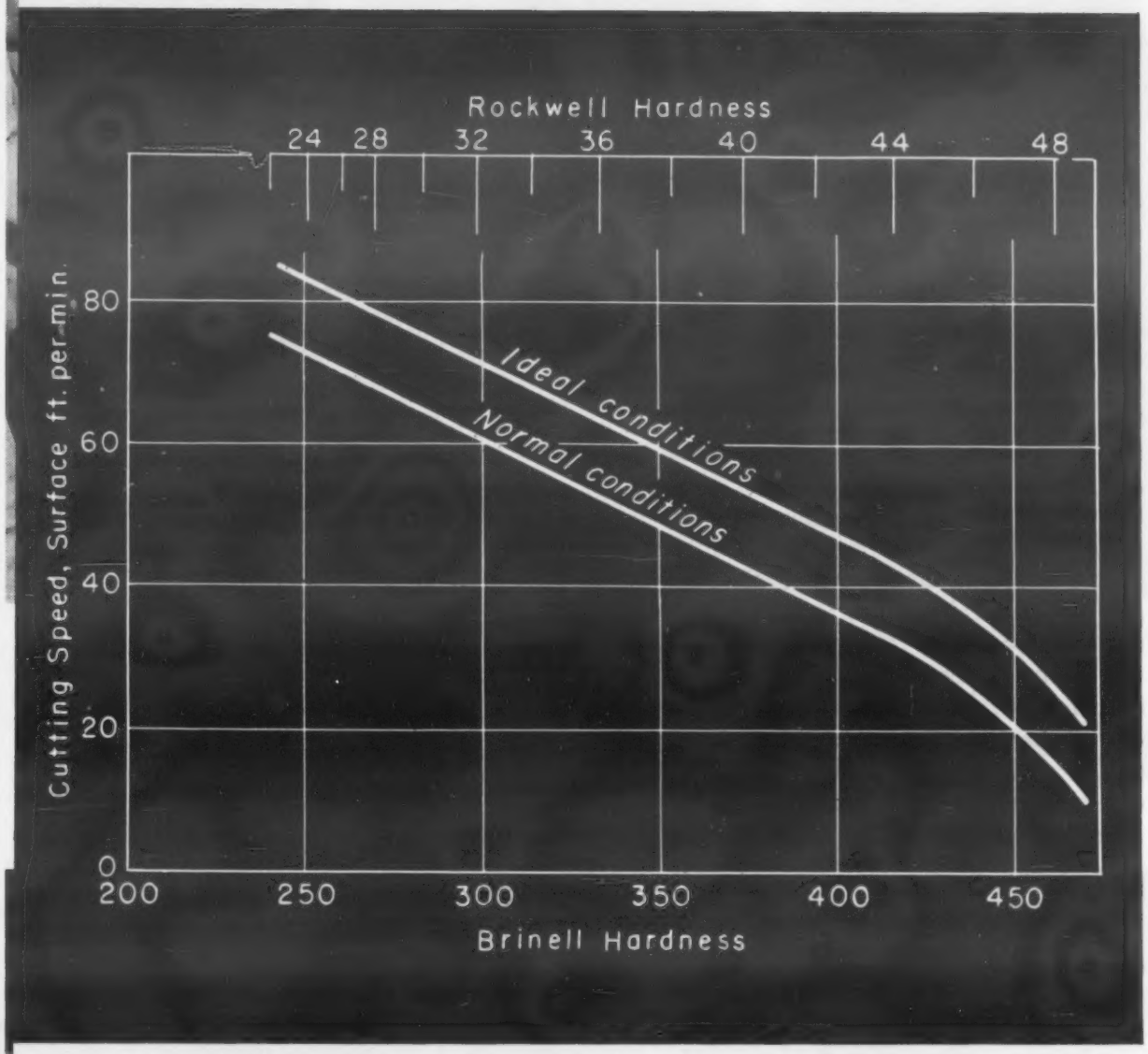
Tools—While carbide tools are used for many lathe and milling operations and even for drilling and reaming, high speed steel tools can be used on all operations. Certain operations such as gear cutting are always done with high speed steel tools.

Rake angles may be generous when machining heat-treated steels in the low hardness range but in higher hardness range the rake angle should be small, around 5 to 8 deg. The clearance angles should also be reduced to add more support to the tool.

Careful grinding of the tool is more important in machining heat-treated steels than when cutting annealed steels. Smoothing the faces adjacent to the cutting edge, using the correct angles, polishing the flutes of drills, all add to the tool life.

Surface treatments of high speed steel tools, such as nitriding, give best results when used on finishing operations on hardened steel. Flash chromium plating has shown excellent results on finishing operations using light cuts at hardness above 40 Rockwell C.

Cutting Speeds—The chart shows cutting speeds which may be used for single point turning of quenched and tempered steels using high speed steel cutting tools. The curve for ideal conditions refers to a good type of steel, properly heat treated to best structure, free from non-metallic inclusions and operated with proper



Suitable speeds for single point turning of quenched and tempered steels using high speed cutting tools.

tools under a rigid set-up. Since ideal conditions are not always possible, the curve for normal conditions is a more practical working curve.

For operations other than single point turning, reduced cutting speeds are advisable, depending on the type of operation. For example, spline hobbing might be about 60% of the values shown on the chart. For cast alloy tools the speeds may normally be increased 25 to 50%, and for carbides from 2 to 3 times the above values.

Machining Conditions— A rigid machine set-up is expressly important in machining steel at high hardness. Any play in the machine or any chatter of the tool will cause rapid dulling or chipping of the tool.

Cutting Fluid — The high shear strength of heat-treated steel puts considerable pressure on the cutting tool face and encourages welding of the chip to the tool. To combat this tendency the use of sulfurized oil has become common practice, especially when using high speed steel cutting tools. For most operations a sulfurized base diluted with paraffin oil to proper consistency gives best results. On such operations as gear cutting, spline hobbing and broaching, a thicker oil is used than when drilling or turning. In many turning, milling and drilling operations sulfurized emulsion type cutting fluids have proved satisfactory.

On very slow cutting operations such as broaching and thread cutting where the surface speed is less than about 40 ft per min, chlorinated cutting fluids have proved to be well worth their cost. The chlorinated compounds seem to be superior to the sulfurized compounds at low speeds and heavy pressures. A combination of the two types has given excellent results on some really tough machining jobs such as tapping quenched and tempered alloy steels.

Carbide cutting tools are used both dry and with emulsion type cutting fluids, depending on hardness of metal cut and depth of cut.

Type of Operations—In general, as with annealed steel, turning operations with single point tools are the easiest to perform when cutting quenched and tempered steel at high hardness. Drilling and face milling operations are next and slotting operations such as slot milling, spline hobbing, gear cutting and external thread chasing present some difficulties. Reaming and broaching may vary from job to job because the light cuts accentuate the work-hardenability of the metals cut, some jobs cutting easily and others with more difficulty. One of the most difficult operations to be performed on hardened steel is tapping, particularly in small, blind holes. For that reason it is desirable to drill and tap before hardening whenever possible, particularly if part will have hardness greater than 36 Rockwell C.

Maximum Practical Machinable Hardness—While every shop has individual ideas, it is the writer's opinion that under ideal conditions parts may be considered practical to machine at hardness up to about 44 Rockwell C, on such operations as turning, gear cutting, spline hobbing and drilling. A maximum of about 40 Rockwell C is desirable for broaching and slot milling, while about 36 Rockwell C is preferable for tapping. These values are for high speed steel cutting tools. Higher hardness can be cut but reduced cutting speed and shorter tool life render it generally impractical from the cost standpoint.

Carbide cutting tools, properly used will do surprising things. The writer has observed the drilling of a number of 1¼-in. dia steel balls (slightly flattened on two sides) that had been hardened throughout to 62.5 Rockwell C. A 7/16-in. dia carbide drill operating at 635 RPM (73 surface ft) and feeding at the rate of about 0.34 in. per min. drilled through 1⅛ in. of metal in less than 4½ min. (The drill was removed frequently to free the drill from chips). While some of the balls cracked from heat checking, the entire bore remained file hard. Emulsion was used as a coolant. This is not an isolated instance. At least one other similar operation has been done in other plants and has been reported in the literature. It is merely an example of what can be done.

Machine shops that are planning on increased machining of heat-treated steels, or that are having difficulty with such operations should review the comments made above, particularly with regard to preparation of the part to be machined and rigidity of the set-up, in order to eliminate conditions that might cause trouble.

Picture Credits: Joseph T. Ryerson & Son., Inc., Air Reduction Sales Co., Westinghouse Electric Corp.

by MYRIL C. SHAW,
General Secretary, Asbestos Textile Institute

Asbestos Textiles—

What They Are
What They Can Do

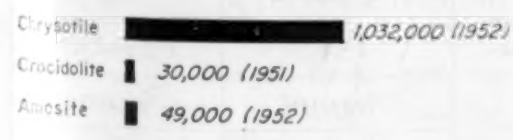
Chrysotile fibers from which asbestos textiles are made.

The first comprehensive article on this old and important engineering material.

● ASBESTOS IS THE NAME given to a group of fibrous minerals that occur in different forms in many countries throughout the world. Some types of asbestos are adaptable to textile processing, and asbestos textile products are widely used in industrial and consumer products. In addition to their well-known incombustibility, asbestos textiles offer retention of strength at high temperatures, insulation against heat, electrical resistance, and a considerable degree of resistance to water and chemicals.

Chemical Composition of Chrysotile, %

SiO_2	37-44
MgO	39-44
FeO	0-6.0
Fe_2O_3	0.1-5.0
Al_2O_3	0.2-1.5
H_2O	12-15
CaO	Trace-5.0



Annual production of three most important asbestos fibers (metric tons).

Types of Asbestos

The "asbestiform" group includes 30 or more minerals of fibrous crystalline structure but only six have economic significance. These are, in order of importance, chrysotile, crocidolite, amosite, anthophyllite, tremolite and actinolite. Because it is superior to other types of asbestos for textile processing, as well as for industrial purposes generally, chrysotile accounts for about 95% of the total world production of natural mineral fibers. This relationship is shown in the accompanying graph.

Chrysotile is basically a hydrated silicate of magnesium occurring as veins in serpentine rock. The nature and amount of "impurities" vary. Atoms of iron may replace magnesium in the crystal lattice. Elements such as calcium, aluminum and others may be present in amounts so small they are disclosed only by spectrographic analysis.[1] Small pieces of magnetite and, to a lesser extent, chromite may also be found in fiberized chrysotile. Despite these variations, chrysotile is generally more uniform in quality than other types of asbestos. The different types of chrysotile and their characteristics are discussed later.

Crocidolite is mineralogically an amphibole of the hornblende group. The blue material is a complex silicate of iron and sodium subject, like chrysotile, to considerable variation in composition. It is more difficult to process into a spinnable fiber than chrysotile, although some yarns and other textile products are made of this fiber. Its resistance to heat is lower than that of chrysotile but its tensile strength is quite high. Its most important advantage is superior resistance to acid attack. Major source is South Africa, with other deposits in Australia and Bolivia. Bolivian crocidolite is not strong enough for textiles but has good dielectric properties and is suitable for felting.

Amosite is a silicate of iron and

appears to be a fibrous modification of the monoclinic amphibole, grunerite. Amosite has good tensile strength and is more heat resistant than chrysotile or crocidolite. Its fibers are flexible and unusually long but because of their relative harshness they are not well adapted to spinning. Amosite is used mainly in thermal insulation. South Africa is the only commercial source.

Anthophyllite is essentially a silicate of magnesium and iron, usually with a small amount of aluminum, and is classified mineralogically as an orthorhombic amphibole. Its fibers are usually brittle and low in strength and therefore unsuitable for textiles. Recently, however, specimens of high-magnesium anthophyllite have been discovered that are soft and pliable and suitable for textile uses.

Tremolite is a monoclinic calcium-magnesium silicate whose fibers are often long and silky but generally too brittle and of inadequate tensile strength for textile uses. It is of value chiefly for filtration purposes because of its freedom from iron and its resistance to attack by acids. Principal source is northern Italy.

Actinolite is similar in composition to tremolite except for the presence

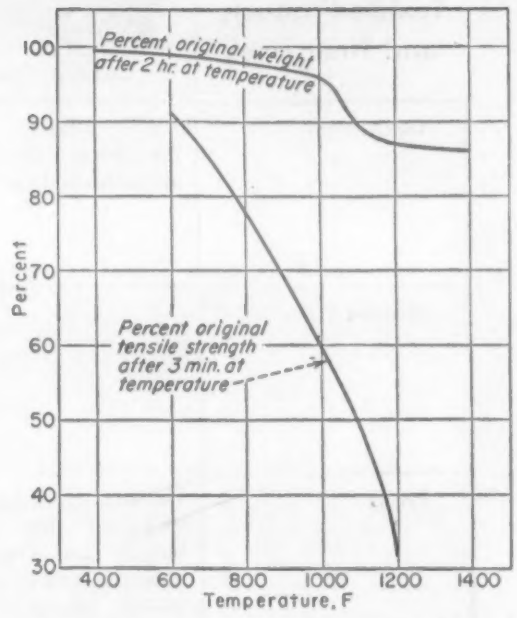
This asbestos material provides a long lasting door gasket for a sterilizing autoclave used in a hospital.

Table 1—Properties of Asbestos Fibers

	Chrysotile	Crocidolite	Amosite	Anthophyllite	Tremolite	Actinolite
Essential Composition	Hydrous silicate of magnesia	Silicate of sodium and iron with some water	Silicate of iron and magnesium; higher iron than anthophyllite	Magnesium silicate with iron	Calcium and magnesium silicate with some water	Calcium-magnesium-iron silicate; water up to 5%
Specific Gravity	2.4–2.6	3.2–3.3	3.1–3.25	2.85–3.1	2.9–3.2	3.0–3.2
Texture	Soft to harsh, also silky	Soft to harsh	Coarse but somewhat pliable	Harsh	Generally harsh, sometimes soft	Harsh
Flexibility	High	Good	Good	Poor	Poor	Poor
Spinnability	Very good	Fair	Fair	Poor	Poor	Poor
Luster	Silky	Silky to dull	Vitreous, somewhat pearly	Vitreous to pearly	Silky	Silky
Color	Green, gray, amber to white	Blue	Gray, yellow to dark brown	Yellowish brown, grayish white	Gray-white, greenish, yellowish, bluish	Greenish
Fusion Point, F	2770	2180	2550	2675	2400	2540
Specific Heat, Btu/lb/F	0.266	0.201	0.193	0.210	0.212	0.217
Resistance to Heat	Good. Brittle at high temperatures	Poor, fuses	Good. Brittle at high temperatures	Very good	Fair to good	—
Hardness, Moh	2.5–4.0	4	5.5–6.0	5.5–6.0	5.5	6±
Tensile Str., 1000 Psi	18–469 (av, 72)	100–300	16–90	4.0 and less	1–.8	1.0 and less
Electric Charge	Positive	Negative	Negative	Negative	Negative	Negative
Filtration Properties	Slow	Fast	Fast	Medium	Medium	Medium

Table 2—Asbestos Compared with Other Commercial Fibers

Fiber	Tensile Strength, 1000 psi	Diameter, Mils	Surface Area, 1000 Sq In./Lb (by nitrogen absorption)
Asbestos (Chrysotile)	18–469 (Av-72)	0.00071–0.00118	9100–16,000
Wool	17–28	0.8–1.1	670
Cotton	42–125	0.4	510
Silk	45–83	—	530
Acetate Rayon	18–30	—	270
Nylon	65–117	0.3	220
Glass	250–315	0.26	—



Effect of heat on strength and weight of chrysotile.

of iron which replaces some of the magnesium. Like tremolite, the fibers are too weak and brittle for spinning but have good resistance to acids. Its practical value is limited and production is small.

Properties of Chrysotile

The properties of chrysotile fibers that particularly adapt them to the manufacture of asbestos textiles are: length, strength, toughness, flexibility or pliability, and a minimum of magnetic or conductive particles. Length of commercial chrysotile fibers ranges downward from ¾ in. with usually only the longest available fibers used for textiles. Chrysotile fibers have high tensile strength and are more flexible than any other asbestos fibers. These and other properties of chrysotile are listed in accompanying tables, along with comparable properties of other types of asbestos and other commercial fibers.

Heat resistance studies by the Asbestos Textile Institute show that the chrysotile structure is stable up to about 1490 F; above that temperature the structure is permanently changed to another non-fibrous crystalline structure called "olivine." However, loss of part of the water of crystallization produces notable deterioration in fiber quality at 750 F. Further deterioration occurs at 1300 F where almost all water is removed. The effect of heat on the tensile strength of chrysotile is shown in an accompanying graph.

Chrysotile varies from soft to harsh in texture in various localities and therefore differs in its adaptability to textile processing. Canada is the principal source of chrysotile. Africa and Arizona currently supply about 10% and 5%, respectively, of U.S. requirements. Canadian chrysotile usually has a dark green luster, but the fibers appear white when fully opened, and is often referred to as "white asbestos." Arizona chrysotile, with low magnetic iron content, is particularly adapted for use as electrical insulation. In addition to the sources listed above, chrysotile deposits have been found in Turkey, Venezuela and Columbia. Large deposits are also located in Russia but production data are unavailable.

Processing Asbestos

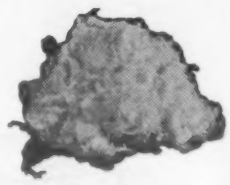
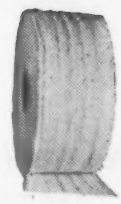
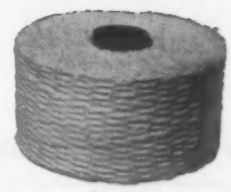
Chrysotile is removed from the earth by both open pit and underground mining. The average yield from Canadian mines is less than 5% asbestos fiber, and only about

Table 3—Grades and Temperature Limits

Grade	Asbestos Content, % By Weight (ASTM D 299-52T)	Highest Recommended Service Temp, F
Commercial	75 up to but not including 80	400
Underwriters'	80 up to but not including 85	450
Grade A	85 up to but not including 90	550
Grade AA	90 up to but not including 95	600
Grade AAA	95 up to but not including 99	750
Grade AAAA	99 up to and including 100	900

Table 4—Ferrous and Nonferrous Types of Asbestos

Type	Total Iron Content (Max), %	Magnetic Rating (Max), ASTM D1118-50T
Ferrous	6	3
Nonferrous		
Underwriters' Grade	1.75	0.75
Grades A, AA, AAA and AAAA	2	1

Asbestos Textile Products and Their Uses	 Carded Fiber	 Lap	 Roving	 Yarn	 Cord
Description	100% asbestos that has been fiberized, screened and carded.	Felted form of carded fibers blended with organic fibers.	Assemblage of carded fibers blended with cotton or other organic fibers and condensed into a single strand without twist.	Roving mechanically twisted to provide tensile strength.	Several strands of yarn twisted together to provide high tensile strength.
Grades		Underwriters', A, AA, AAA.	Underwriters', A, AA, AAA.	All ASTM grades.	All ASTM grades.
Types	Various qualities determined by fiber length and type of asbestos, and by operations necessary to produce carded fiber.	Styles: single, ribbon-like formation (I); paralleled assemblage of style I lap (II). Ferrous or non-ferrous (see Table 4). Weight: 250–4200 grams per linear yard.	Plain or reinforced (with core of cotton or other thread for added strength). Ferrous or non-ferrous (see Table 4).	Plain (sometimes with small amounts of organic fibers); metallic (fine wire insert); or reinforced (insert of other fibers. Untreated or treated (coated or impregnated for special purposes). Twist: "S" or "Z". Ply: single or multiple. Weight: 500–5000 yd/lb.	Diameter: 1/16 to 3/8 in. See Yarn.
Typical Uses	Filtration of beer, wine, oil and chemicals (fibers can be furnished in many degrees of fineness to provide exact texture needed). Stuffing box packing. Pad for wiping excess metal from wire during coating.	Re-carded into insulation for heater cords, fixture wires, other electrical conductors. Re-corded laps are spiraled around conductor to form homogeneous wall.	Wrapped by wire covering machines to form relatively soft insulating sleeve over heater cords, cables and electrical heating elements.	Woven, braided or formed into cord, thread, cloth or tubing.	Core for electric resistance wire; insulation for glass handling tools; seal on high temperature corrugated metal gaskets; valve stem packing; braided wall on steam hose. Metallic cords used for flare signal cords; suspending crucibles.
Available Forms	10-, 25- and 50-lb cartons. Boxes containing 1 lb and less.	Rolls wound on paper tubes varying in size according to the number of slivers in the assemblage.	Rolls wound on cones and tubes varying in size according to customer requirements.	Rolls wound on paper tubes of various lengths to meet individual requirements.	Fractions of pound packaged as balls. Quantities of 1, 5 and 10 lb wound on tubes and spools. Larger quantities up to 50 lb wound on spools or reels.

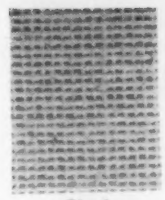
4% of the asbestos fiber extracted from the world's mines in recent years consists of grades suitable for processing into textiles.

The asbestos fiber is divided into two main groups: crude and milled. The crude fibers, which measure 3/8 to 3/4 in. and longer, are recovered separately by a hand method known as cobbing in order to preserve the long fibers intact. The milled fibers, which include all grades up to 3/8 in. in length, are recovered by mechanical milling, together with a vacuum cleaner type separation.

Asbestos fibers are graded primarily according to length. This is done by a shaker box test, known more formally as the Quebec Asbestos Producers' Association Screen Test. The results of this test are given as four figures representing the number of ounces of a 16-oz sample that are retained, respectively, on the top 1/2-in. screen, an intermediate 4-mesh screen, a bottom 10-mesh screen, and a "fines" box below the bottom screen. Canadian chrysotile fibers are classified in nine groups, of which only the first three are suitable for processing into textiles. Specifications for the three textile groups are listed in the accompanying table.

At the textile plant the crude or milled fibers are subjected to further refining operations known as fiberization. This process continually subdivides the fiber bundles until they are separated into soft, silky fibers and also removes impurities and undersize fibers.

After fiberization, different grades

 Thread	 Wick	 Rope	 Cloth	 Tape	 Tubing
Yarn treated with special compounds to produce smooth, uniform finish.	Soft, pliable strand formed by loosely twisting together several strands of roving, slubbing or felted asbestos.	Several strands of wick twisted together, braided yarn, or a combination of both.	Fabrics woven from yarns.	Narrow woven fabric with selvage edges.	Yarns braided or woven to form flexible sleeve.
Underwriters'.	Commercial. Other grades on order.	Commercial (most general uses). Underwriters' AA, AAA and AAAA for high temperature applications.	All ASTM grades.	Underwriters' (for electrical purposes), and all other ASTM grades.	All ASTM grades.
Plain or metallic (see Yarn).	Plain or reinforced (with cotton yarn). Diameter: ¼ in. standard ⅛–½ in. also available.	Twisted: (two or more strands of wick twisted lightly together); or braided: 1. One or more jackets of yarn braided over core of rope or wick. 2. Successive braids of yarn to form either square or round cross-section. 3. Square cross-section of plaited yarn. Diameter: ⅛–2 in.	Plain, metallic or reinforced (see Yarn). Treated or untreated. Weave: plain, twill, broken twill or herringbone. Thickness: 0.015–0.100 in. (single ply) to ½ in. (multiple ply). Width: 36 and 40 in. (others on order). Weight: ½–5 lb/sq yd.	Ferrous or non-ferrous (see Table 4). Plain or metallic (see Yarn). Thickness: 0.010–0.25 in. (plain); 1/16 in. and up (metallic). Width: ½–6 in. Weight: 0.3–72.0 lb/100 ft (plain); 1.5–84.0 lb/100 ft (metallic).	Braided or woven. Inside Diameter: 1/64 in. to several inches (braided); less than 1 in. up to 22½ in. (woven). Wall thickness: less than 1/32 to about ⅛ in.
Hand or machine sewing of asbestos fabrics used in theater curtains, belting and safety clothing; sewing insulating jackets on pipes; wrapping electric resistance wires; tying incandescent gas mantles on lighting equipment; fastening insulation at each end of heater cords.	Utility packing for hot lines and valves; weather seal for corrugated roofing; caulking for retorts, ovens and furnaces. Special wick used to wipe excess metal from wires in coating, and as core for high temperature packings.	Used where material thicker than wick desired. Twisted: seal between furnace doors and brickwork; cover for diesel engine exhaust lines; core for high temperature packing. Braided: Groove packing for inspection doors; filling for expansion joints in furnace brickwork; gasket for doors and water gas generators.	Fireproof curtains, draperies, blankets, clothing; facings for oven conveyor belts; covers for ironing boards; industrial furnace hoods; jackets for hot pipes; dust bags for mechanical dust collecting systems; reinforcement for molded and laminated plastics. Metallic cloths used as base in friction materials; mechanical packings and gaskets; insulation for boilers and turbines.	Light plain tapes: electrical insulation as in motor windings. Heavy plain tapes: flameproof, oil- and water-resistant wrapping for lead sheathed cables; cover for hot pipes; component of packings and gaskets; conveyor belting. Metallic tapes: brake linings, clutch facings; oil burner wicking; conveyor belting.	Braided: sleeving for electrical appliance leads, lead wires of thermocouples; covering for pincers and tongs used to handle glassware. Woven: insulation of bus bars, auto heaters; flexible convection in hot air ducts; dust bags for filtering hot waste gases.
Wound on tubes as specified by user.	Balls of ¼, ½ and 1 lb. Wound on 10-, 25- and 50-lb coils or on reels and packed in individual cartons.	Wound in 10, 25 and 50-lb coils or on reels and packed in individual cartons.	Rolls of 50 and 100 yds.	Rolls wound on bushings (for electrical insulation). Packing for other uses varies.	Braided: wound on 25- or 50-lb spools or reels. Woven: rolls, or cut to specified lengths.

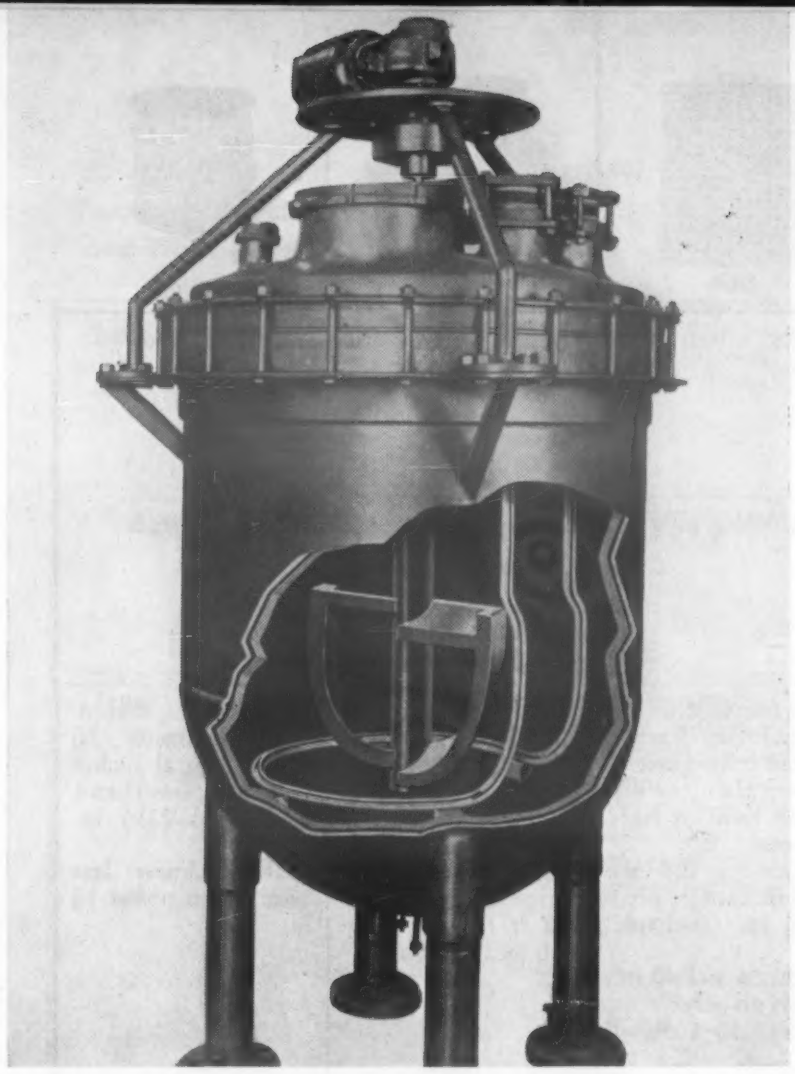
of asbestos fibers are blended according to the particular processing or service characteristics desired. Small percentages of organic fibers such as cotton or rayon may be added as carriers or supporting agents to improve spinning properties or to meet certain end requirements.

Subsequent operations are similar to conventional textile processing. Carding completes the opening and cleaning of the fibers and combs them into a relatively directional and tenuous web. Carded ribbons are rubbed mechanically and condensed into untwisted strands known as roving or, sometimes, wound parallel into roll forms known as laps. Rovings are spun, twisted and formed into asbestos yarns which are then woven into flat or tubular forms in many textures, weaves, weights and thicknesses. Many kinds of braids, both round and square, can also be be produced.

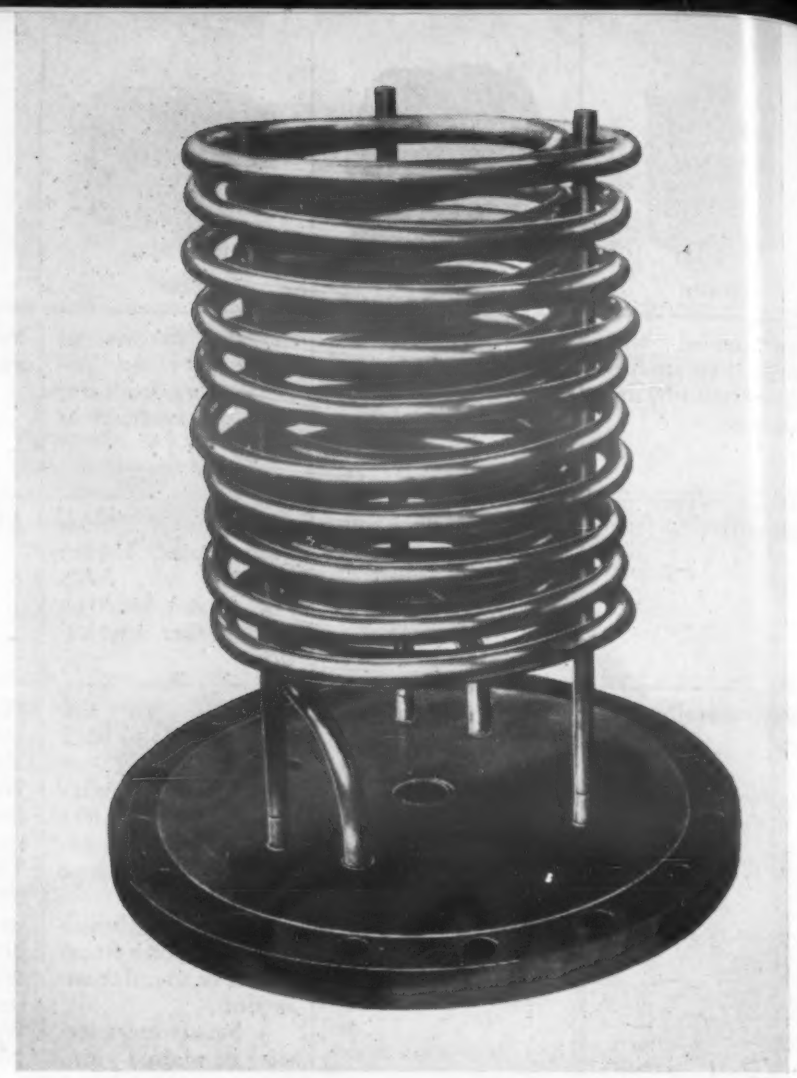
Table 5—Textile Groups

Group	Grade Designation	Fiber Length
1	Grade No. 1	¾ in. and longer
2	Grade No. 2	⅜–¾ in.
3	Spinning Fibers (milled)	Guaranteed Min Shipping Test
	3F	7–7–1½–½
	3K	4–7–4–1
	3R	2–8–4–2
	3T	1–9–4–2
	3Z	0–8–6–2

This article is based on the "Handbook of Asbestos Textiles" published recently by the Asbestos Textile Institute.



Tantalum heating coil in a process kettle which may be ceramic or glass lined steel. Unit like this usually costs less and is heated more efficiently than steam jacketed kettle.



This large heating coil uses tantalum tubing on a steel flange protected by a tantalum tube sheet.

Where To Use Tantalum

- ***No longer a laboratory metal, its properties make it desirable for corrosion resistant and electronic products.***
- ***Although still costly, it has proven economical in many special applications.***

by TOM M. GAYLE

It has been during only the last few years that most engineers have come to know the metal tantalum as anything but a rare laboratory oddity. The general availability of tantalum in recent years, however, has led to a number of interesting plant applications. While the metal is still too costly ($40 to $70 per lb depending on shape and finish) for general use, its function in many specialized applications has proven economical in reducing maintenance and assuring product quality.

Tantalum is probably best known for its corrosion resistance to practically all acids. In many respects, the chemical properties of tantalum are quite similar to those of glass. It is inert in the presence of most acids, but reacts quite readily with hydrofluoric acid or strong alkali solutions. Unlike glass, however, tantalum is malleable, ductile, resistant to thermal shock and is capable of high thermal conductivity.

Tantalum is basically a refractory metal and cannot be extracted from its ore by conventional methods. Separation processes for the metal are chemical and electrolytic rather than thermal in nature. After the essential salts are separated from the ore, they are reduced to metallic powder which is then compacted by high mechanical pressure to form bars. The minute particles of the bars are then bonded by a sintering process which gives the metal its high mechanical strength. Subsequent drawing, rolling, and other forming operations are all accomplished without heating.

Tantalum is currently available in sheet, foil, rod, wire, and tubing. Special forms and shapes as well as completely fabricated parts such as coils, condensers, heat exchangers, and bayonet heaters are also available for particular applications.

Corrosion Resistance Uses

Tantalum's excellent properties as an acid resistant material account for the majority of its industrial applications. Although the metal should

not be employed on hydrofluoric acid and with certain limitations on strong sulfuric and phosphoric acids, its immunity to other acids including hydrochloric and aqua regia is outstanding.

Tantalum has been used with eminent success in hydrochloric acid services where all other metals fail. Heat exchangers, bayonet and coil heaters, and condensers of tantalum have come into wide usage because the corrosion resistance of tantalum is combined with high thermal conductivity. Thermal conductivity is about three times as great as that of stainless steel and better than forty times that of glass.

The mechanical strength of tantalum compares closely with that of steel. Therefore, in the construction of many types of tantalum chemical equipment, much thinner wall sections than would be used with other metals can be designed due to the absence of all corrosion. The thinner sections not only keep the cost down but also provide greater heat transfer efficiency. In most of the heat exchanger designs, only the exchange surfaces are of tantalum with the housing, piping, fittings, etc. being of glass-lined metal, glass, or plastic.

Typical difficult heat exchange applications in which tantalum is outstanding may be found in the metal finishing industries. The use of tantalum coil heaters and bayonet heaters to maintain temperatures in pickling baths and electroplating baths has eliminated a long standing problem for many plants.

Wet or dry chlorine as well as practically all chlorinated compounds can be handled advantageously with tantalum. Below about 300 F, tantalum is almost totally immune to attack by chlorine, bromine, and iodine in any form. Many fragile glass parts in water chlorinating equipment are being replaced by tantalum with excellent results. The fact that the metal is immune to either wet or dry chlorine is important in these applications.

Other services in which the immunity of tantalum is notable are those involving hydrogen peroxide, esters, keytones, and aldehydes. The pharmaceutical industry uses tantalum in contact with many complex organic compounds where a contamination free product is essential.

Some of the most rewarding uses of tantalum for the engineer seem to lie in many small "problem" applications that seem to defy the successful use of any metal. Rotameter floats and small orifice plates are two rather critical pieces of equipment that can usually be economically fabricated of tantalum.

In addition to corrosion resistance, tantalum exhibits marked resistance to erosion in many services. Its use for nozzle tips and ejector throats for corrosive fluids is sometimes practical. The pump rod plunger for the small acid displacement pump is another critical piece of equipment that is well suited to tantalum's properties. Here, the shock resistance, tensile strength, and rigidity required tend to rule out the use of glass or plastic material.

Tantalum in sheet form can frequently be used to overlay another metal and provide a protective veneer in contact with the corrosive stream. The lining of flanges and other flat surfaces is simple and often pays dividends in reduced maintenance and replacement. Sheet tantalum is also well suited to the use of gage seals and isolators for pressure gages and instruments. Thermometer and thermocouple wells of tantalum are quite satisfactory since the high thermal conductivity assures fast response and accuracy.

While tantalum offers an imposing list of assets, it also presents certain limitations which should be noted. It is particularly susceptible to corrosion by fluorine or fluorinated compounds in most any form. Its immunity to chlorine is definitely limited to temperature below 300 F. The use of tantalum in contact with any type of alkali solution, free SO_3, or free hydrogen should be avoided. Electrolytic effects occurring when tantalum is bonded to another metal and immersed in an electrolyte are particularly detrimental to tantalum. Some type of insulation should be provided between the tantalum and the other metal in order to break the electrochemical circuit.

Other Uses

A number of interesting applications of tantalum have become firmly established in the field of electronics. Its high melting point, low vapor pressure, low thermal expansion, and weldability have led to its widespread use as a grid and plate material in electronic power tubes. The fact that tantalum does not become embrittled in vacuum even at very high temperature means that tantalum plates may be reclaimed and reused.

The lack of embrittlement coupled with low thermal expansion makes the metal especially suitable for critical support pieces in the many vacuum furnaces used by industry for material testing. Another property of tantalum which makes it attractive for high vacuum work is that at high temperatures it tends to immobilize gases and thus maintain high vacuum. A currently available tantalum-tungsten alloy has the property of maintaining its elasticity at high temperatures in vacuum. Springs and clips made of the alloy are commonly used in vacuum tubes.

Tantalum possesses the characteristics of forming unusually stable anodic films on its surface. The fact that these films offer high resistance to current flow in one direction only has led to the development of tantalum rectifiers. The immunity of tantalum from attack by acid electrolytes has made the metal an ideal material for use in electrolytic condensers.

Working and Fabrication

The working of tantalum into useful shapes requires some careful consideration but is usually not exceedingly difficult. The machining properties of tantalum are good, although the metal exhibits the "sticky" properties characteristic of copper and soft aluminum. Tearing can usually be prevented by operating at speeds corresponding to more than 100 surface feet per minute. Carbon tetrachloride is usually recommended as a cutting fluid and in practically all machining operations, the work should be well flooded.

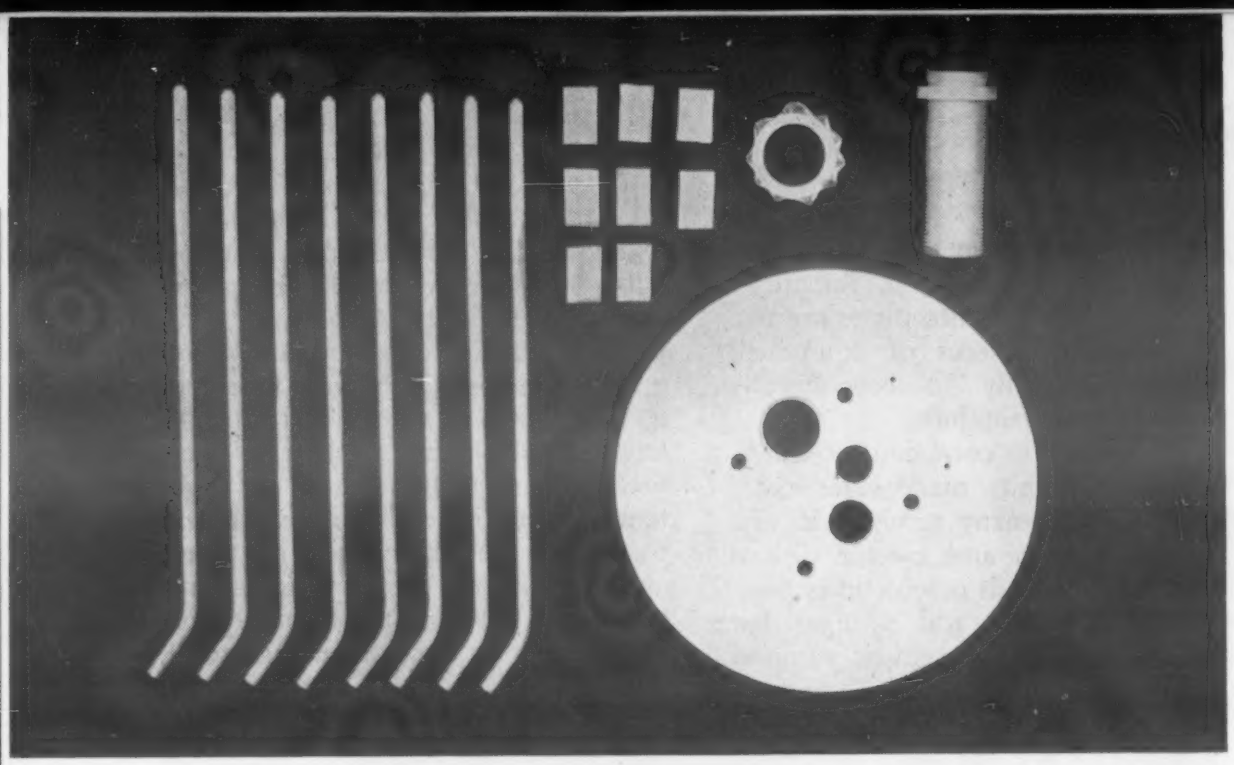
Successful gas welding of tantalum is almost impossible and should not be attempted. Arc welding is quite difficult and is best left to factory experts. Resistance welding, however, is not difficult and can usually be accomplished with standard equipment. Specific information on spot, seam, and butt welding techniques can be obtained from the tantalum supplier.

All bending, stamping, and other forming operations should be carried out without heating the tantalum. These operations are usually simplified by the fact that work hardening in tantalum takes place quite slowly.

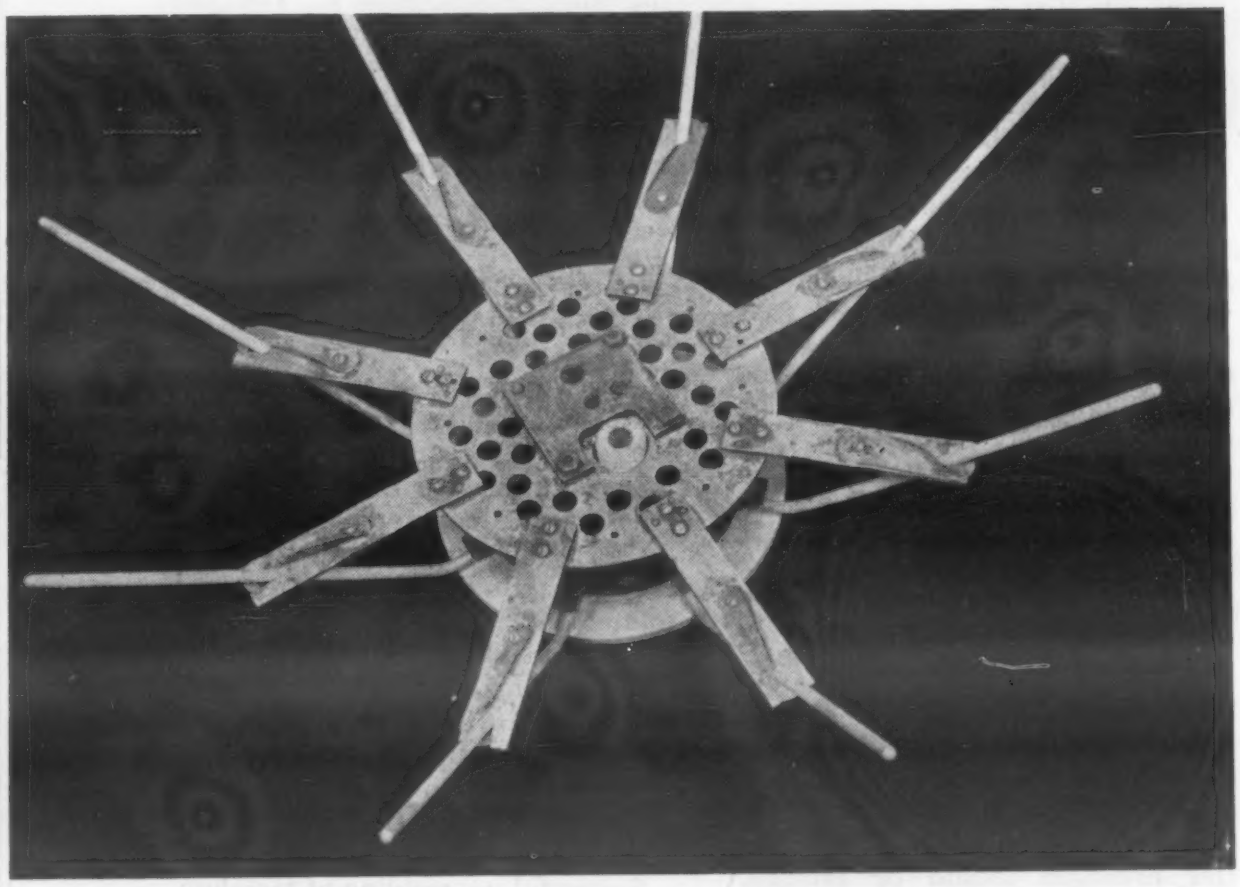
Acknowledgment

The author wishes to acknowledge the helpful suggestions in the preparation of this article given by Mr. L. Scribner, Chief Engineer, Tantalum Div., Fansteel Metallurgical Corp.

Picture Credits: Fansteel Metallurgical Corp.



1 *Parts to be joined by dip brazing prior to assembly*



2 *Parts assembled in holding fixture preparatory to brazing*

Close Tolerance Aluminum Parts Brazed in Salt Bath

When properly done, dip brazing 1) lowers unit cost 2) reduces scrap 3) produces joints as strong as those by other methods.

by WILLIAM J. RUDOLPH,

Chief Metallurgist and Brazing Engineer, Tremer Manufacturing Co.

● THE DEVELOPMENT OF salt bath brazing of aluminum during the past few years has advanced to the point where it is possible to produce specialty parts on a production basis. For example it is now possible to fabricate micro-wave components holding tolerance of ±0.002 in. Heat exchangers with fin thickness of 0.005 to 0.010 in. can be brazed without pitting or burning the fins. In the aircraft field dip brazing has increased production, lowered the cost per unit, greatly reduced scrap losses while yielding joints comparable in strength to those of the other methods. However dip brazing does have limitations and was developed not to eliminate other fabricating processes but for use where welding and riveting are not practical.

Brazing Procedure

Brazing is basically the same for all details to be joined, whether the parts are to be held to tolerances of ±0.002 in. or to fractional tolerances of 1/8 in. or even 1/4 in., the only difference being in the tooling. The procedure consists of 1) deburring; 2) pre-cleaning; 3) assembly; 4) pre-heating; 5) dip brazing and 6) flux removal.

Deburring — Unlike welding, where the parent metals are fused and penetration is required to make a sound joint, brazed joints are produced by melting and flowing the brazing alloy into the joint area by capillary action or gravity flow. The brazed joint penetrates only a minute distance into the parent metal. This is called surface penetration. Since the joint is not made by fusion, the slightest burr will at times restrict the flow of the brazing material resulting in skips and voids in the joint area. There are times when the fluxing action of the salt bath will overcome small burrs and a sound joint results; however, it is not a good practice to rely on the activity of the flux to accomplish this. Therefore, burrs should be removed mechanically from the edges to be joined.

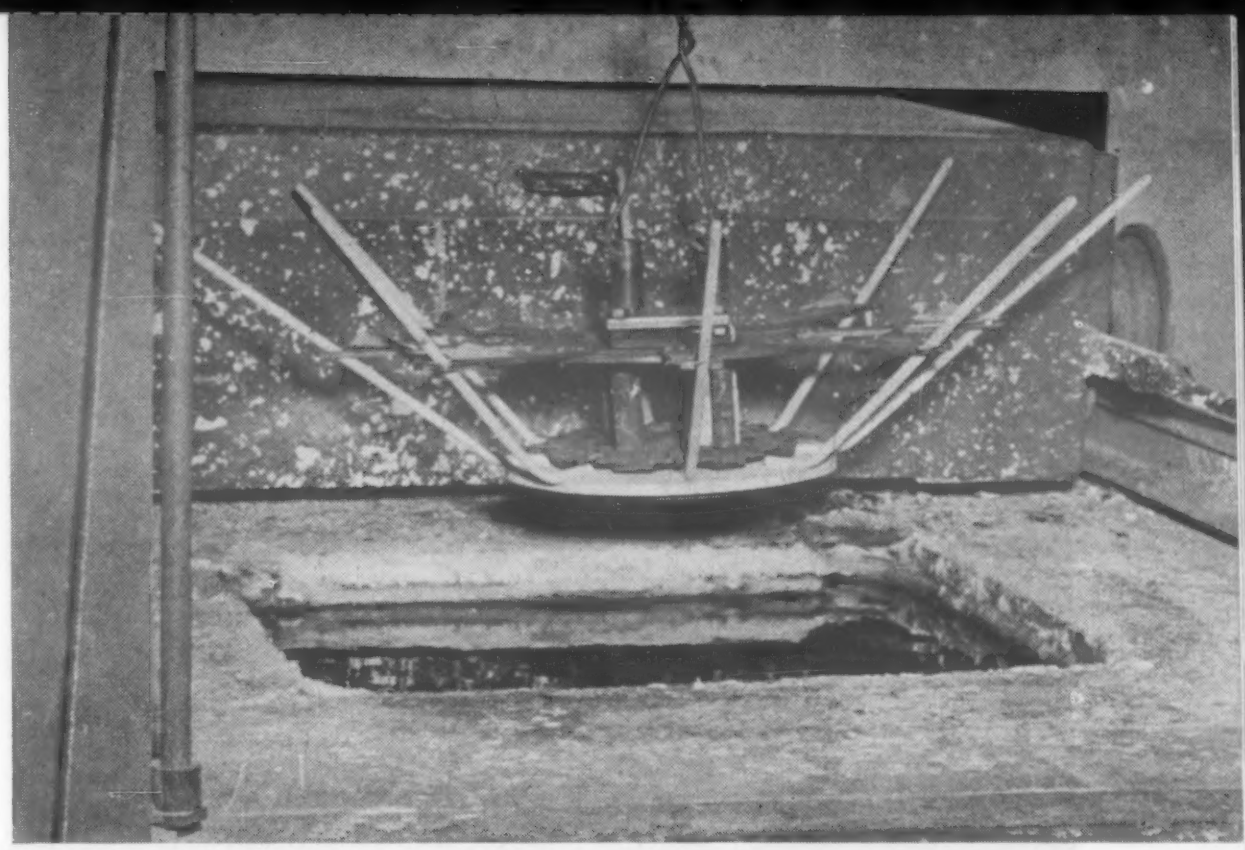
Pre-Cleaning — To obtain sound joints, pre-cleaning is necessary. Degreasing can be accomplished by vapor or solvent methods. After degreasing, the parts are chemically cleaned in a 10% nitric, 1/4% hydrofluoric acid solution for from 3 to 5 min. If acid cleaning is extended beyond the prescribed time cycle, a greater surface resistance will tend to build up and the quality of the braze

will be impaired. Where machined parts are to be joined by brazing, these parts should be immersed in caustic soda at 190 F for 30 sec followed by a water rinse and a 5 min immersion in nitric acid. However a nitric-hydrofluoric immersion may be substituted for the nitric dip. In this case the procedure would be 30 sec immersion in caustic followed by a cold water rinse, and a 2 min immersion in nitric-hydrofluoric acid, followed by a cold and then a hot water rinse.

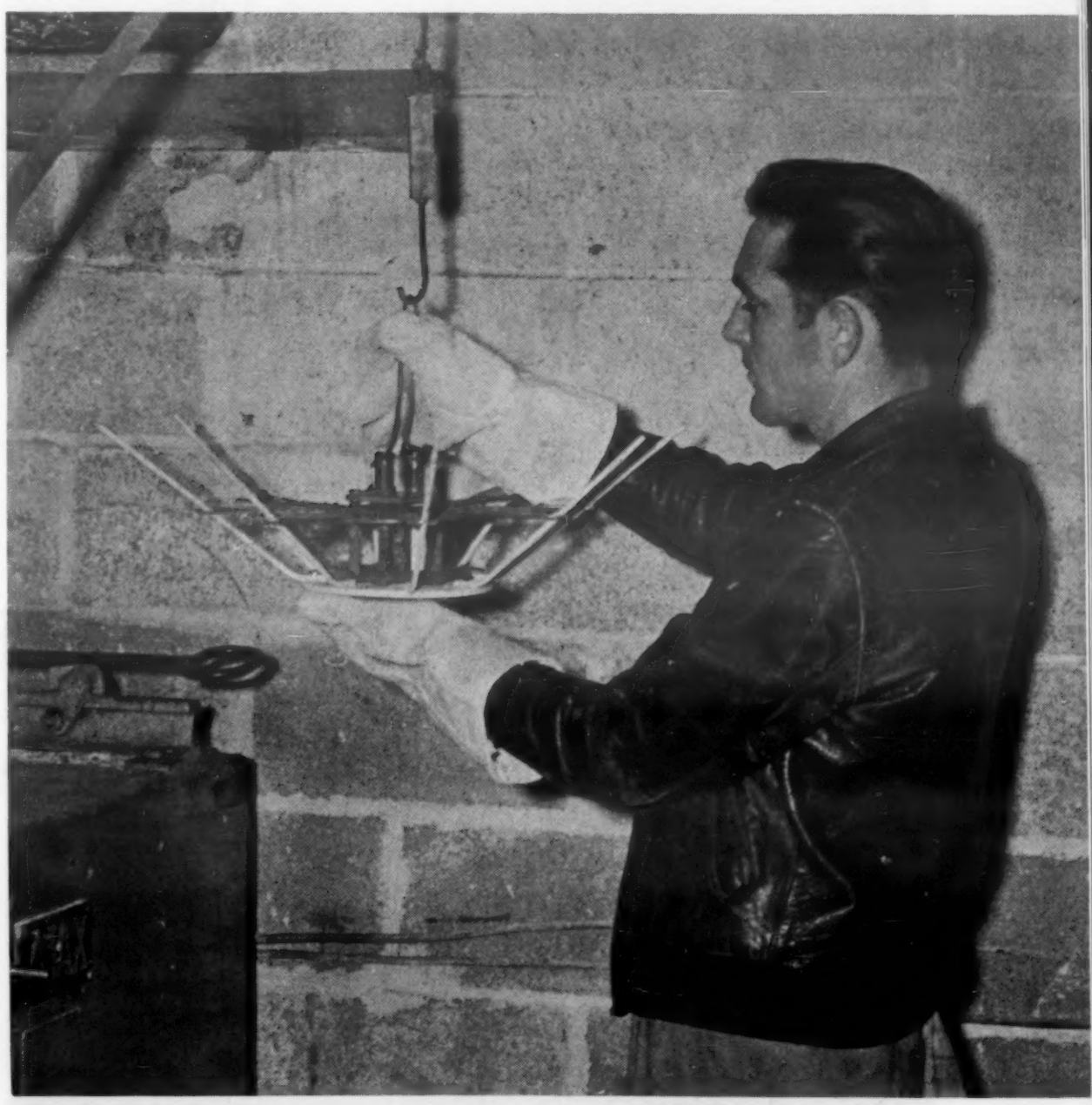
Assembly — This is probably the most important factor in the dip brazing process. Assembly and tooling go hand in hand in almost every instance. The details should be carefully checked against the drawing and the proper type brazing wire selected. Where very small fillets are required and the flow of the brazing material is by capillary action a brazing material between 0.003 in. and 0.006 in. in thickness is recommended. If in doubt a general rule is to select a material width three times the thickness of the parts to be joined. This holds true for materials up to 1/8 in. in thickness. For example, if the details to be joined are 1/16 in. thick, the width of the flat brazing wire would be 3/16 in. On the other hand if round wire in the form of wire rings, etc. would prove to be more practical it becomes necessary to determine the desired wire diameter by trial. Round wire ranges from 1/16 in. to 1/4 in. dia. However, this wire can be drawn down to 0.020 in. dia or less by using a set of step down dies. At Tremer Mfg. Co., we have found Alcoa No. 718 brazing wire a good general purpose filler material.

Having selected the proper filler material and formed it to the proper shapes (washers, rings etc.), the parts are assembled with the brazing material in position. These parts are placed in the brazing fixture which helps to locate and support the parts during brazing. The parts can be held in position by tack welding, spring loaded fixtures, spring clamps, staking, self locating joints, and by spot welding into position.

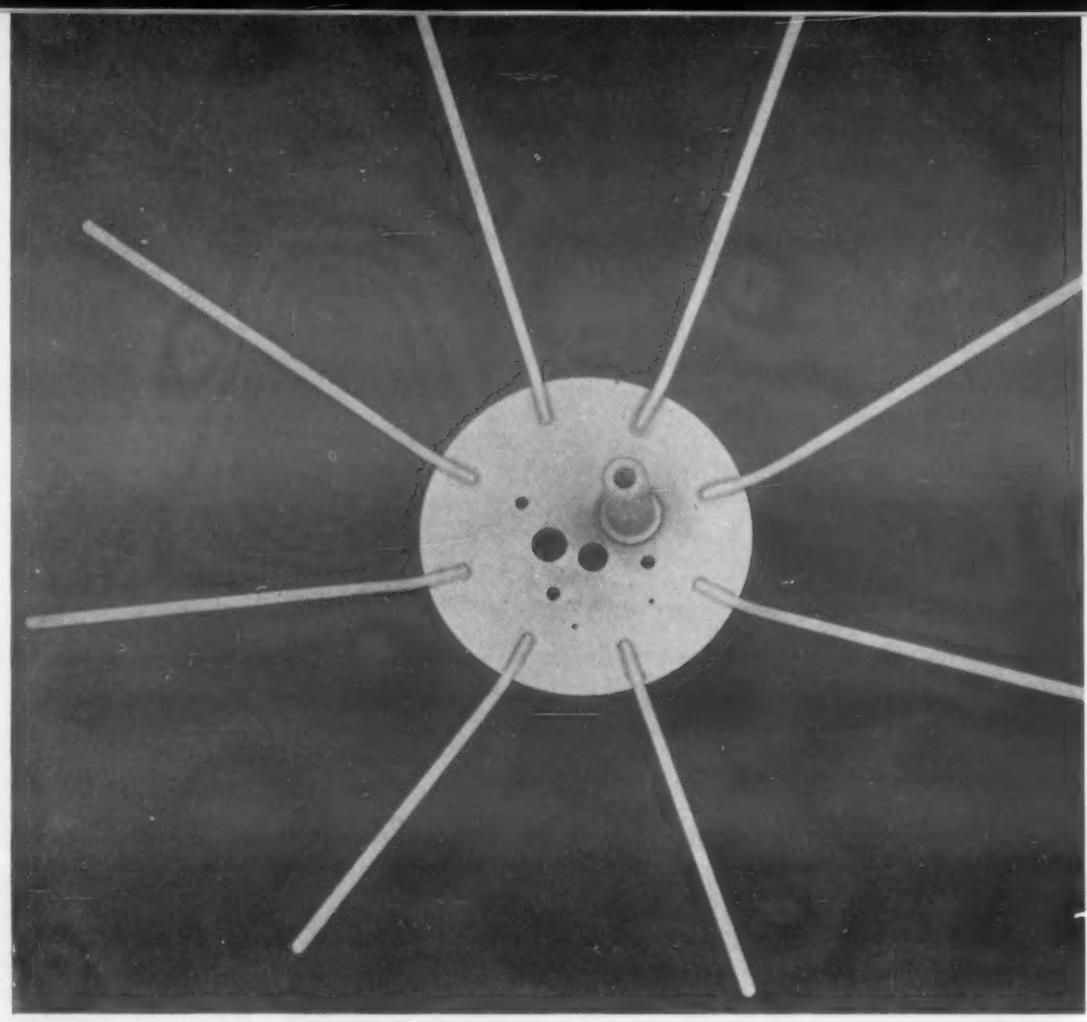
Where tolerances must be held to 0.002 to 0.005 in., it is necessary to employ spring loaded fixtures. It is possible to hold close tolerances by tack welding the units on specially designed joints and sub assemblies. If tolerances range from 1/32 in. up and parts are fabricated from



3 *Pre-heating before brazing by suspension over salt bath*



4 *Assembled part being removed after brazing*



5 ***Finished product after cleaning***

materials of 1/16 in. or heavier, tack welding provides a very effective means of holding and locating the parts for dip brazing.

Pre-Heating — After assembly, the unit is placed in a pre-heat furnace at 950 to 1030 F for 5 to 15 min depending upon the mass of material to be pre-heated. This operation is essential to remove moisture, prevent local freezing of the molten fluxes when unit is immersed in the salt bath and aid in eliminating distortion.

Brazing — Salt bath brazing is accomplished by immersing the pre-heated parts into a bath of molten flux with the bath temperature ranging from 1085 F to 1120 F for a period of 45 sec to 3 min, depending upon the mass of material, the fixturing required and the thickness of the assembled parts. The temperature of the salt bath should be within ±5 F of the brazing temperature throughout the pot. The time and temperature cycles should be determined by trial employing a direct reading potentiometer attached to the pilot assembly and the controlling instrument of the salt bath set to the proper brazing temperature. At Tremer, an Ajax submerged electrode salt bath furnace is used.

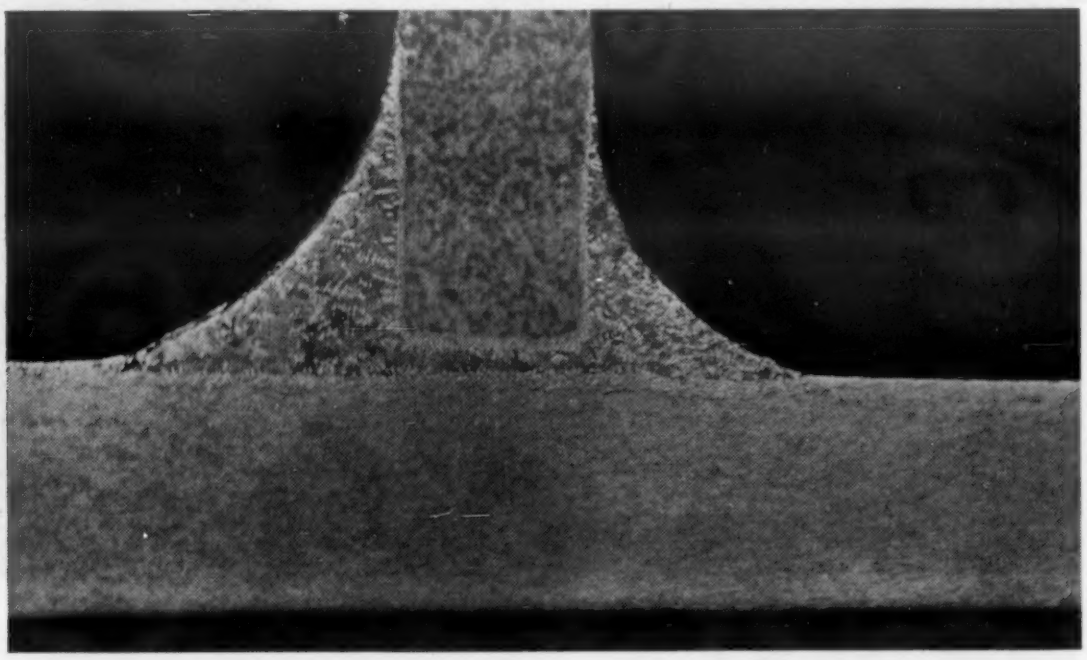
Having immersed the fixture for the proper time, the unit is removed from the bath. If heat-treating is desired the unit can be immersed in cold water immediately after removal from the salt bath. However, on units such as micro wave components where close tolerances must be held, the unit should be allowed to cool to room temperatrue before immersing in water. This aids in preventing distortion of the detailed parts.

After cooling the unit is removed from the fixture and cleaned. When brazing the standard brazeable alloys (E.C., 2S, 3S, 61S, etc.), The temperature should range from 1090 F to 1110 F. If these alloys are held in this temperature range, holding in the bath beyond the prescribed time will not ruin the parent material. In some instances, parts have been allowed to remain in the bath for as long as ten minutes and were still usable. In dip brazing, assemblies can be re-brazed as many as three times and step dip brazing may be done with satisfactory results. In cases where mistakes of locating details, or skips and voids appear in the joint areas, the unit does not have to be scrapped for it can be repaired, new parts machined, relocated and the complete unit re-brazed.

Flux Removal — The flux should be removed immediately after brazing. Fluxes employed in dip brazing are highly corrosive to aluminum and will start corrosive action almost immediately. The removal of the flux is no problem if the design of the assembled parts is such that good drainage can occur while the parts are being removed from the salt bath.

Upon removal from the dipping bath, the unit is immersed in hot water for a period of 5 to 20 min, depending upon the amount of flux entrapped and the ease of entry of the water into the entrapped areas. The flux is water soluble and can be removed rapidly in hot water at 190 to 212 F. The assembly is then immersed in a 10% nitric-¼% hydrofluoric acid solution from 5 to 10 min. The nitric acid has little attack on the aluminum, but will tend to neutralize any fluxes present while the hydrofluoric acid attacks the aluminum and tend to brighten it.

It is just as important to remove all acids from the aluminum as it is to remove the flux, to prevent corrosive attack. This is accomplished by rinsing the parts in a cold water, followed by a hot water rinse. This accelerates drying of the parts and guarantees complete flux removal.

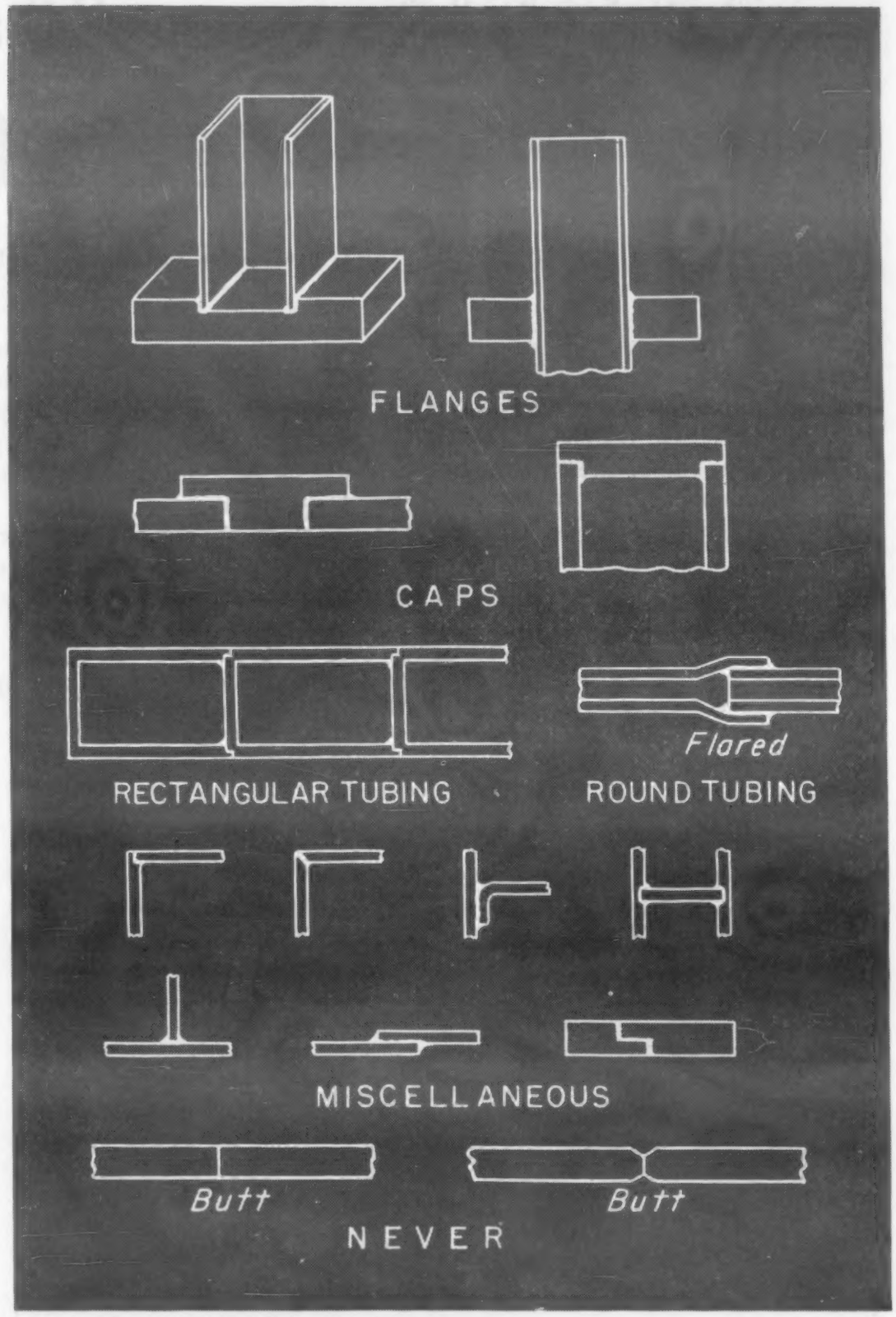


Structure of a typical brazed joint showing fillet formation and penetration

Joint Design and Fixtures

Joint design is a very important factor in all dip brazing especially in the fabrication of micro wave components. Due to the very close tolerances that must be held in the fabrication of these components, it is essential to design as many joints as possible to be self-locating. A self-locating assembly will lower the cost and time of building elaborate fixtures, and will reduce the assembly time considerably. The joint should also be so designed that the parts to be joined are not a tight or pressed fit. Clearance between the parts is necessary to guarantee complete fillets and good flow of the brazing material. This flow depends chiefly on capillary action and gravity. When a joint is designed which requires a flat shim of the brazing material, enough clearance should be permitted between the joining surfaces to allow for the brazing material. The design of the joint should permit complete drainage of the flux. A joint should never be designed where flux can be entrapped, otherwise hot water and acid neutralizer cannot remove it.

When designing for micro wave units it should be recalled that most electronic components call for small smooth inner fillets. This can only be accomplished by employing a small diameter filler wire or flat brazing wire. A flat wire 0.003 in. thick is recommended to keep these fillets small, neat and uniform while producing the strength required. Dip brazed parts should be designed so that alignment during brazing is obtained by the fit of the parts rather than by forces exerted by jigs or fixtures.



Joint designs suitable for dip brazing

Aluminum Alloys Suitable for Dip Brazing

E.C.	Wrought
2S	"
3S	"
53S	"
61S	"
A612	Cast
C612	"
40E	"
11 & 12	Brazing Sheet
21, 22, & 23	" "

Alloys 53S and 61S are hardenable by heat treatment. Brazing sheet consists of 3S or J51S core clad with brazing material. Odd number brazing sheet is clad on one side only, even number brazing sheet is clad on both sides.

The function of the tool is to hold the assembled parts together during the pre-heating and brazing operation. Proper designing and construction of the fixtures is as important as the design of the units themselves. To hold close tolerances the fixture must be within the same tolerances.

During the pre-heating and brazing, the unit is exposed to temperatures ranging from 1000 to 1100 F. At these temperatures the aluminum assembly and the steel fixture expand. Since the expansion of aluminum is greater than that of steel, distortion will take place in the aluminum components if they are held tightly in place. This is eliminated in two ways: 1) stainless steel springs are used throughout the fixture with enough pressure exerted to hold the unit but permitting it to expand without distortion during the pre-heating and brazing operation. 2) The assemblies can be held in place by tack welding, riveting, spot welding, staking, screws, spring clips, etc.

It is advisable to construct all fixtures from stainless steel or Inconel. The springs should also be made from stainless steel. Copper or brass should not be used to hold fixtures when unit is to be dip brazed.

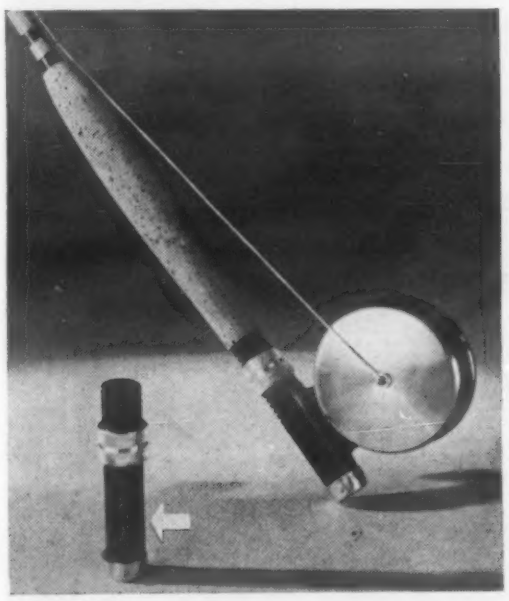
As their potentialities are more widely appreciated . . .

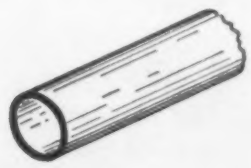
Plastics Extrusions Grow

by **ROBERT MARX**, Development Engineer, Anchor Plastics Co.

The usefulness of plastic extrusions—like most engineering materials—depends a great deal on the imagination and ingenuity of the product designer. In recent years engineers have become increasingly familiar with the design possibilities offered by extruded shapes, both metallic and nonmetallic. At the same time they have become increasingly conscious of the peculiar advantages offered by plastics for many applications, particularly where light weight, resiliency, color or light transmission are important. As a result they have found that where production quantities are sufficient (say at least 500 lb of material) thermoplastic extrusions often offer economical solutions to knotty design problems. On these two pages are described some recent applications of plastic extrusions. Some are fairly obvious—some not so obvious. Together, however, they reflect a growing appreciation of the potentialities of this engineering material, and they may suggest some similar applications.

—Here are brief case histories of recent applications.





FLY ROD

Plastic Extrusion: Cylindrical tube that is joined to one end of glass-reinforced plastic rod, the joint being concealed by a glued-on cork sleeve handgrip.

Function: Reel seat.

Dimensions: 0.700 ± 0.006 in. OD 0.460 ± 0.006 in. ID

Reason for Application: Light weight, corrosion resistance, low machining cost.

Material Requirements: Good strength and rigidity.

Material: Black, butadiene- modified polystyrene.

Fabrication: Threaded, assembled with formed aluminum cap and reel-tightening nut, joined to rod.

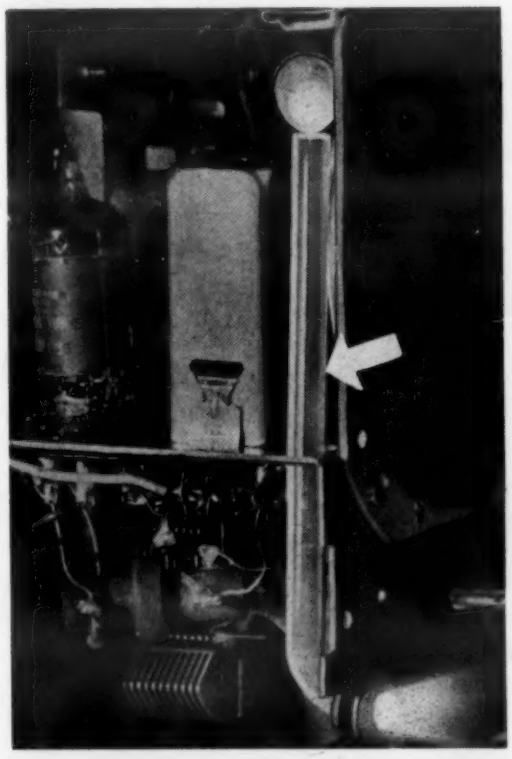


TABLE MODEL RADIO

Plastic Extrusion: Bent solid rod that runs from pilot light in top part of chassis to off-on control knob at bottom of front panel.

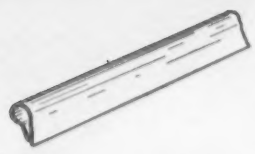
Dimensions: 0.250 ± 0.005 in. dia.

Reason for Application: Pilot light placed at top of chassis for convenience of consumer and to meet Underwriters Laboratory specification. Styling of cabinet requires light outlet at bottom.

Material Requirements: Ability to pipe light efficiently and to conduct it around 90-deg bend.

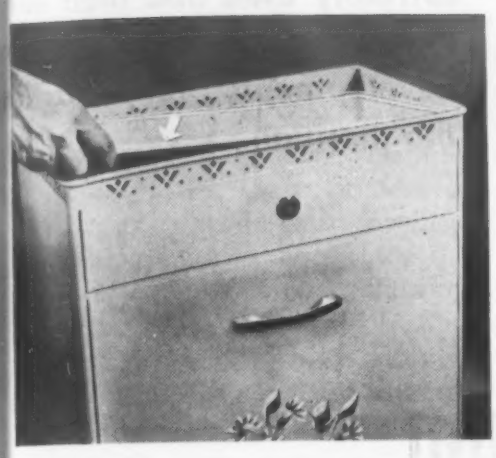
Material: Clear acrylic, free of defects and with high finish.

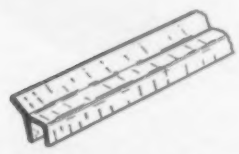
Fabrication: Bent on ½-in. radius. Assembled with least possible number of mechanical contacts to avoid unnecessary reduction of light transmission efficiency.



CRUISING TAPE MEASURE (for lumber)

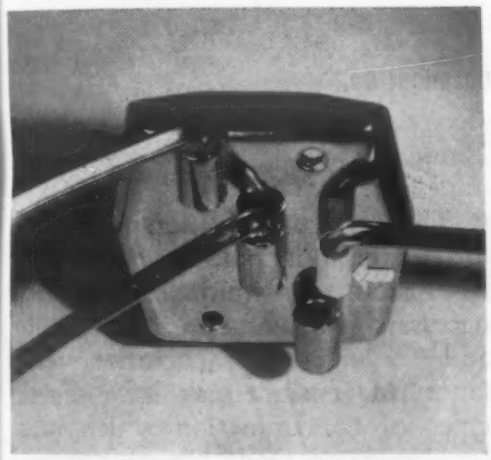
Plastic Extrusion: Edging that snap-fits over lip of rule case.
Function: Bearing surface for sliding tape.
Reason for Application: Protection of scales on back of tape. Bare metal edge of stamped case would scratch printed surface.
Material Requirements: 1. Good wear resistance.
2. Enough stiffness to provide spring-like grasp of metallic edge that withstands frictional pull of tape.
3. Color to match nameplate.
Material: Dark green cellulose acetate butyrate.
Fabrication: Assembly only.





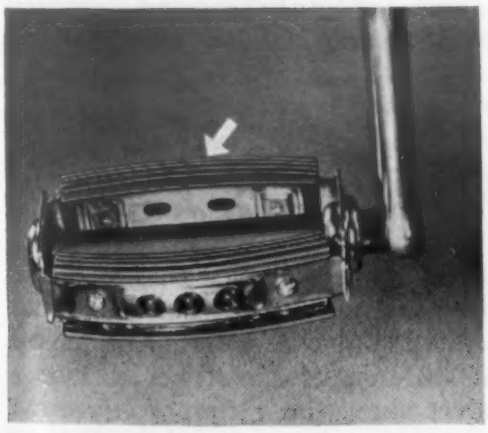
CLOTHES HAMPER

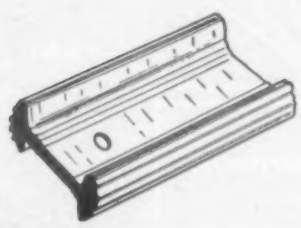
Plastic Extrusion: Flanged channel that fits around perimeter of non-metallic hamper top, the flange squeezing against the metal rim of the hamper.
Function: Mounting gasket, dust seal.
Reason for Application: No fasteners needed, resulting in low assembly costs. Top is easily removable for thorough cleaning.
Material Requirements: 1. Flexibility to meet tolerance variation and provide tight dust seal.
2. Color to blend with metal finish.
Material: Translucent white polyethylene.
Fabrication: Assembly only.



THREE-ARM ALL-PURPOSE RACK

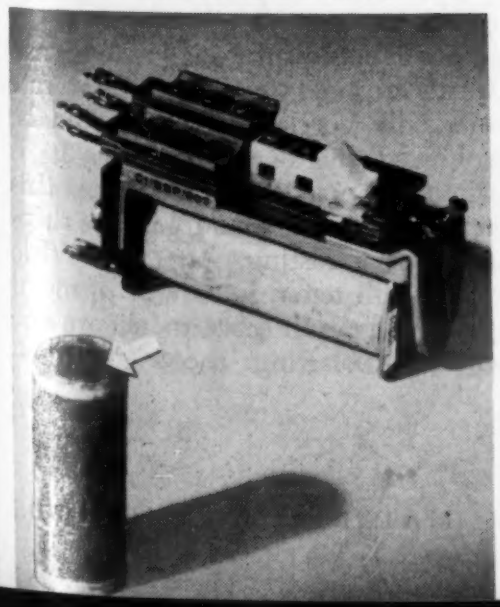
Plastic Extrusion: Cylindrical sleeve that fits over end of each arm inside mounting.
Function: Clutch to assure steadiness of arms in any position without binding or impeding easy movement of arms.
Dimensions: 0.243 ± 0.005 in. OD 0.040 ± 0.002 in. wall thickness.
Reason for Application: Silent braking action, unaffected by humidity. No oiling needed.
Material Requirements: 1. Surface that does not bind.
2. Resilience to compensate for tolerance variations in metal parts.
Material: Polyethylene.
Fabrication: Assembly only.





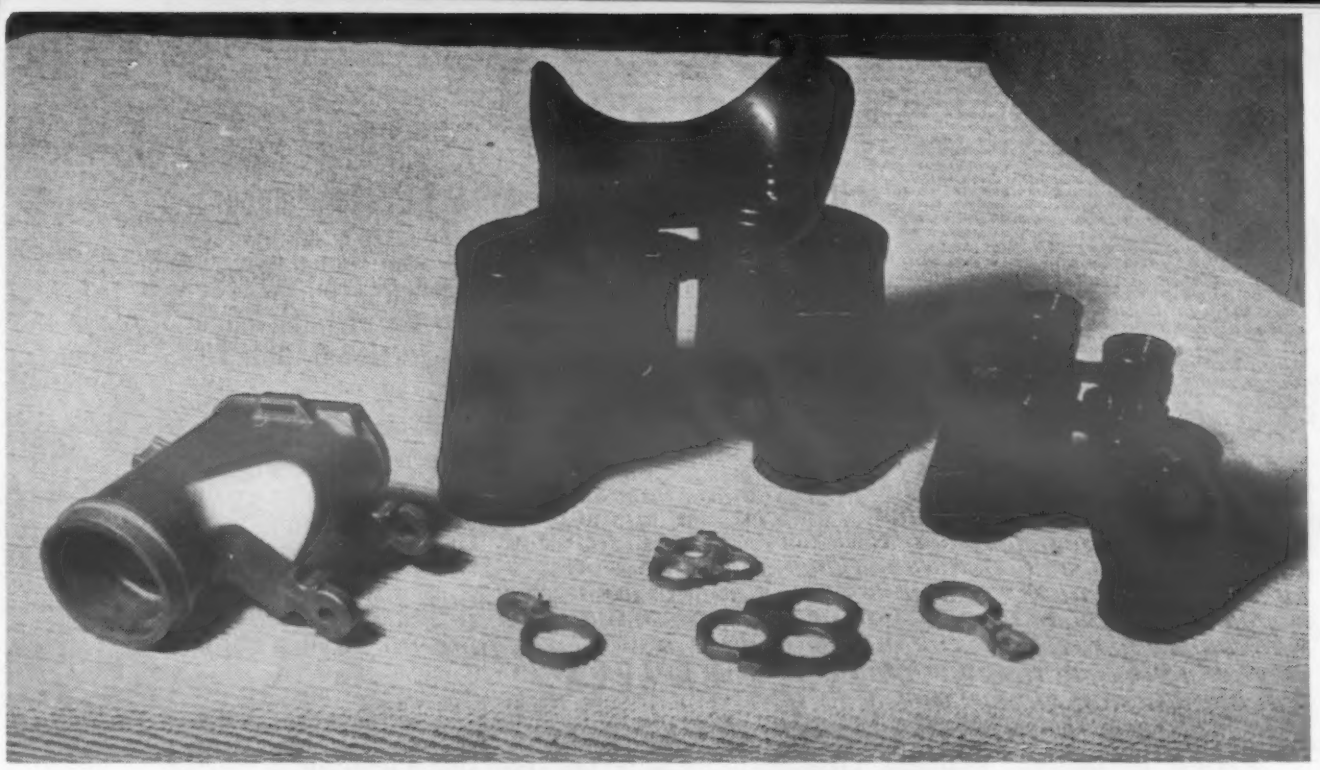
BICYCLE PEDAL

Plastic Extrusion: Corrugated I-beam that is screwed onto metal pedal frame.
Function: Non-slip tread for foot.
Reason for Application: Higher finish than obtainable on conventional rubber tread.
Material Requirements: 1. Wear resistance and general durability.
2. Ease of cleaning.
3. Glossy finish and bright color.
Material: Red or white polyethylene.
Fabrication: Holes punched for screws. Assembled.



RELAY COILS

Plastic Extrusion: Hollow rectangular sections.
Function: Core tubing for relay, transformer, choke and other coils.
Reason for Application: Better durability than plastic spiral wrapped or untreated paper cores. Less brittleness, less tendency to delaminate and lower water absorption. More adaptable to color coding.
Material Requirements: 1. Sufficient rigidity to hold core shape in thin section.
2. Electrical insulating properties.
Material: Cellulose acetate ("hard flow"), any color.
Fabrication: Assembly only.



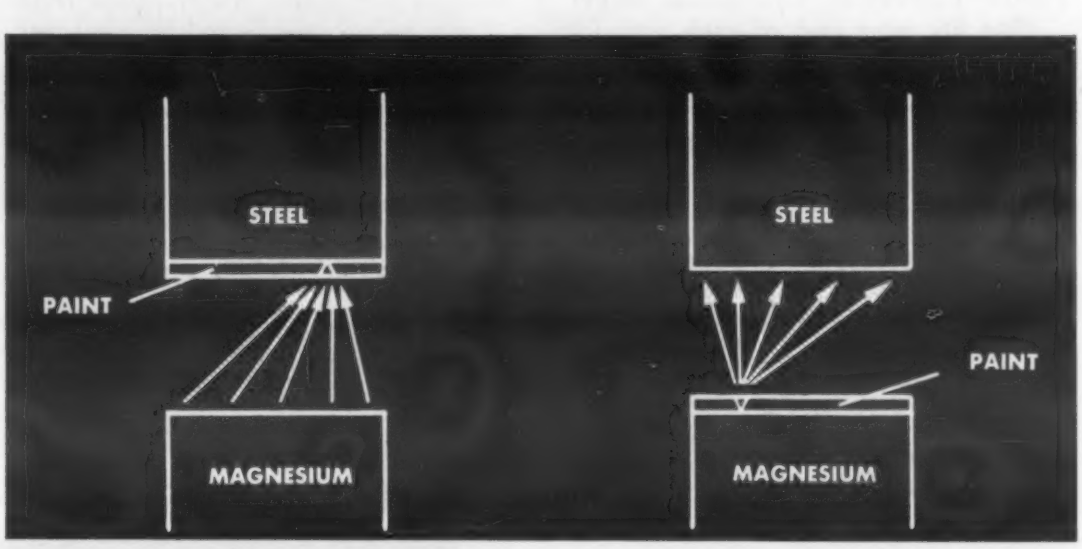
Magnesium binoculars are protected with a black wrinkle finish.

Is magnesium the toug finishing problem som people think it is?

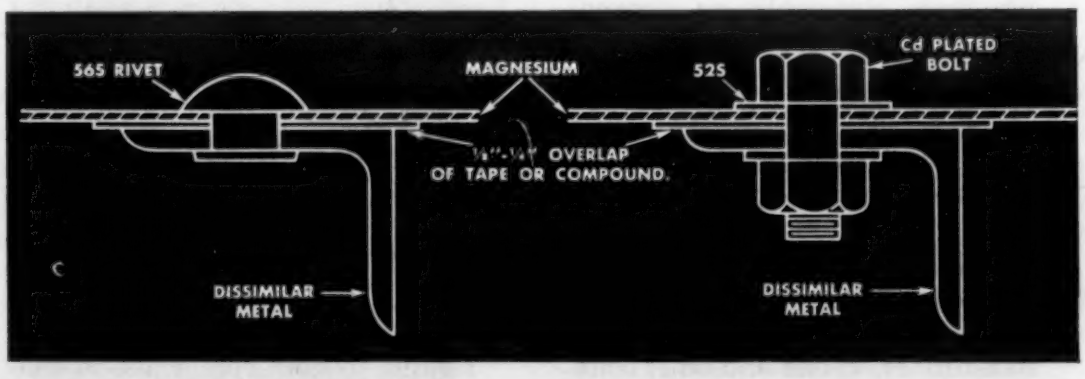
—To answer that questio this article explores 1) r quirements for finishing ma nesium, 2) finishing syste currently used and their se ice experience, and 3) ne developments for finishi magnesium.

Finishing Systems for Magnesium

by HUGO A. BARBIAN, Technical Service and Development, Magnesium Dept., The Dow Chemical Co.



Both magnesium and dissimilar metal should be coated to avoid galvanic corrosion. Left: large magnesium area corrodes superficially if break in paint on steel occurs. Right: penetrating type corrosion occurs in magnesium if break occurs in paint.



Left: Using 565 aluminum rivet with non-absorbent tape prevents galvanic corrosion between magnesium and dissimilar metal. Right: Corrosion will not occur between magnesium and cadmium plated bolt if 525 aluminum washer is used.

● The first consideration for finishing material is obtaining a surface free from contamination. This is necessary for best finishing results and for maximum corrosion resistance. Magnesium may have several types of contamination which must be eliminated. Soils can be removed from the surface with conventional vapor degreasers and alkaline cleaners. An alkaline cleaner of the heavy duty type designed for steel with the pH above 11 is very satisfactory for magnesium.

Magnesium sheet products may have mill scale or heavy metals rolled into the surface. This contamination should be removed with acid pickles for maximum corrosion resistance. Any acid pickle which will remove 0.0005 in. of metal per surface is acceptable, but the acetic-nitrate pickle has been found best. Sheet products may be purchased from suppliers in this pickled condition.

Sand blasting of magnesium castings increases the corrosion rate markedly, so the blasting should be followed by an acid pickle. It is common practice to perform this operation in the foundry before shipment of a casting. Any acid pickle which will remove 0.002 in. of metal per surface will serve to remove the effects of blasting: the 8% nitric—

2% sulfuric or 2 to 3% sulfuric acids are the most commonly used. Chemical treatments like Dow #17 (patent applied for) or HAE remove such surface contamination and sandblasting effects in processing and thus require no previous acid pickle.

Magnesium surfaces, like zinc surfaces, are naturally alkaline. To retard the formation of free alkali at the surface of the metal, a chromate-containing treatment, such as Dow #1, #7, #8, #9 or #10 should be selected. Certain primers which are compatible with alkaline surfaces can be used on bare magnesium with good adhesion. These primers contain vinyl, epichlorhydrinbisphenol, or polyvinyl butyral resins.

Another basic consideration concerns the use of a chemical treatment for paint adhesion. This is a common practice for all metals. Paint adhesion can be obtained mechanically on magnesium with such treatments as the Dow #1 chemical treatment. In a treatment of this type, a selective etching makes a "tooth" into which the paint is locked.

Paint adhesion can also be obtained by absorption. The anodic treatments for magnesium such as Dow #12, #14, Manodyze, #17 or HAE are coatings which will absorb paints, oils, greases, and other such materials very readily. It appears that the Dow #8, #7, #9 and #10 coatings also hold paint by absorption.

A significant phase of magnesium finishing calls for good design and protection of dissimilar metal joints. This becomes especially important where equipment is used in salt-containing environments like sea coast sites or on the underside of automobiles and trucks. In these cases, improper design can lead to galvanic corrosion.

One way to eliminate undesirable galvanic corrosion is to protect both the cathode (dissimilar metal) and the magnesium by the use of moisture impervious films such as vinyls. This is illustrated in the accompanying figure.

Another factor in proper design which tends to reduce the incidence of galvanic corrosion is the use of dissimilar metals which are compatible with magnesium, such as aluminum (52S, 53S, 56S, 61S, 63S), and zinc or cadmium plated steel and brass.

Proper design of magnesium structures calls for the use of non-absorbent tapes or sealing compounds in joints. A tape or sealing compound is used between the magnesium and the dissimilar metal with at least 1/8 to 1/4-in. overlap so that bridging of the electrolyte cannot occur.

Another means of reducing galvanic corrosion is by use of electroplated magnesium. A copper-nickel-chromium system eliminates the potential difference between the magnesium and the dissimilar metal and thus eliminates galvanic corrosion. This method is especially applicable to small parts.

Finishing Systems

There are five main finishing systems currently being used on magnesium parts.

Producer's Paint Base Treatment—A typical example of this system is the use of Dow #1 or chrome-pickle treatment on magnesium die castings or truck body sheet and extrusions. Here the magnesium supplier applies the chemical treatment before selling the product. The customer performs very minor cutting and drilling operations and then applies an organic finish directly to the chemical treatment.

Many commercial products which have been given the producer's paint base treatment and an organic finish have been in service for many years. Some of these are automotive parts with 15 years of service. The parts are primarily die castings which have been given a chrome pickle by the die caster and a coat of baked enamel by the automobile manufacturer. On parts such as convertible hardware, which are exposed to the elements, a coat of primer was incorporated into the system.

Chairs of various types have been in use for over 15 years. These chairs incorporated a baked enamel system over Dow #1. Other chairs have been produced in quantity for more than 5 years with excellent serviceability.

Truck bodies using magnesium sheet and extrusions have been in use for over 15 years and have been produced in quantity for 7 years. Finishing practice here generally consists of the application of primer and lacquer over the Dow #1 applied by the supplier. In some cases where corrosion conditions are more severe as on the under side of the truck body, an undercoating is applied.

Bright Metallic Finish—This finish can be obtained with the Dow #15 treatment on wrought products or the Dow #16 treatment on cast products. The bright metallic finish is used primarily for sales appeal and shelf life. Wax or clear lacquers may be applied for additional finishes.

The bright finish has been used on magnesium ladders for over 5 years and on hand trucks for over 2 years. Normally these parts will remain bright for about a year, but many of the ladders are still very attractive after considerably longer use. In the case of ladders and hand trucks, no wax or lacquer film is applied after treatment.

Black Chemical Finishes — The Dow #8 and Dow #9 treatments are used primarily where black chemical finishes are desired on surfaces which will receive no subsequent organic finish.

Binoculars and camera parts requiring the black chemical treatment show excellent stability after 10 years of service. The black treatment without an organic finish is applied to the inside for best optical effects. The outside is given a baked wrinkle finish or covered with leatherette.

Electroplating—The use of electroplated magnesium has not been too widespread in recent years, primarily because of the nickel shortage. This year several production products are being electroplated and this finishing system is expected to grow. Satin chrome finishes have been applied to die cast portable saw parts for 5 years. Service has been excellent.

Paint Base Treatment—This is one of the most widely used, and is differentiated from the producer's paint base treatment in that his chemical treatment is applied by the fabricator after all fabricating operations are completed and immediately before application of the organic finish. The treatments which may be used are Dow #1, #7, #8, #9, #10, #12, Manodyze, #17, HAE, and Iridite, #15. Of these, the Dow #7 is the most widely used. One of the largest applications has been their use on B-36 planes more than 7 years. Serviceability has been excellent, and although there have been some finishing troubles, proportionately, these troubles have been minor.

Hundreds of pieces of electronic equipment have been manufactured and placed in use over the past 5 years. Some of these include computer cases which received the Dow #7 treatment plus zinc chromate primer plus baked black wrinkle

finish. A reflector for electronic equipment received a Dow #7 plus zinc chromate primer plus a black lacquer. Extensive serviceability data are not available on these parts, but there have been no complaints.

Another application is a bakery delivery cabinet which has been in use for 4½ years. This cabinet received the Dow #1 treatment initially without further treatment. This cabinet is cleaned frequently in an alkaline cleaner which undoubtedly removes most of the Dow #1, so the product has been used essentially in the bare condition.

These serviceability data indicate 1) that magnesium can be finished properly to do the intended job, 2) that a variety of acceptable finishes is available, and 3) that proper design is important for maximum corrosion resistance.

New Finishes

During the past several years much progress has been made in the development of new chemical treatments for magnesium alloys. At least two new magnesium anodizes, the HAE treatment and the Dow #17, have been developed. In addition, Allied Research, Inc., of Baltimore has announced a surface conversion coating known as Iridate #15 (Mag-Cote). Dow has also developed the phosphate touch-up treatment for the repair of damaged surfaces.

Anodizes — The new magnesium anodizes are sufficiently similar to warrant discussing them together. The HAE treatment is formed in an alkaline bath and is light tan to brown in color. The Dow #17 is formed in an acid bath and is light to dark green in color.

Advantages of these treatments are:

Uniformity of Application. The high voltage, up to 110 volts, used in either of these treatments assures uniformity of application. Non-uniformity of coating has been one of the chief problems in magnesium finishing. Even if these anodizes show no other advantage over the surface conversion coatings, their uniformity of application would be sufficient improvement in magnesium finishing to warrant large usage.

Excellent Corrosion Resistance. In almost all cases tested the corrosion resistance of magnesium alloys is increased many fold with use of either of these two new anodizes. Salt spray resistance greater than 10,000 hr with waxed panels has been reported.

Surface Cleaning Features. Contamination rolled in the sheet or resulting from sand blasting on castings is eliminated by using the anodizes, because the coating forms underneath the surface contamination and removes it. Undoubtedly this surface cleaning is largely responsible for the increased corrosion resistance noted, inasmuch as premature failures of magnesium surfaces often have been traced to inadequate cleaning of the surface.

One Step Treatment. The new anodizes are essentially one-step treatment. All good finishing requires alkaline cleaning and water rinse to move excess soils. After cleaning the parts are immersed in the anodizing baths and coated. Other than rinsing and drying in the normal manner, no further treatment is required. The acidic nature of Dow #17 insures good paint adhesion. In some cases HAE has utilized a hydrofluoric acid post treatment where parts are not painted, but in general no post treatment is necessary.

Excellent Paint Adhesion. The new anodizes are very absorbtive. When paints of low viscosity are chosen and allowed to be absorbed into the coating, excellent paint adhesion is obtained and retained over prolonged exposure periods. These organic coatings when absorbed into the film will tend to lock the particles of the anodize coating on the surface of the metal.

High Temperature Stability and Fire Resistance. During the anodizing process the coating is formed at local points where sparking occurs. At these local points very high temperatures are encountered so that coating itself is stable above the melting point of magnesium. It has been demonstrated that metal treated with these new coatings can be heated with a blow torch until the metal inside the coating actually

Test Results on New Anodizes

Test	Finish System	Results
20% salt spray	Dow #17 plus paint	2400 hr to failure
	Dow #7 plus paint	600 hr to failure
Humidity test	Dow #17	no corrosion 3 months
	Dow #7	25% corrosion 3 months
	Bare	100% corrosion 3 months
Paint adhesion	Dow #17	very good
1 year weathering	Dow #7	fair to good

New Anodizing Treatments

Dow #17 Treatment	
Electrolyte	Ammonium acid fluoride Sodium dichromate Phosphoric acid Water
Operating Conditions	
Current density:	5–50 amps/sq ft
Time:	1–30 min.
Temperature:	160–180 F.
Voltage:	Up to 110 v a.c. or d.c.
HAE Treatment	
Electrolyte	Potassium Hydroxide Aluminum Hydroxide Tri Sodium Phosphate Potassium Fluoride Potassium Manganate Water
Operating Conditions	
Current density:	Variable—15 amps/sq ft preferred
Time:	60–90 min at 15 amps/sq ft
Temperature:	75–85 F.
Voltage:	Up to 100 v a.c.

melts and swells without damage to the coating. Furthermore, with the Dow #17 coating, when the molten metal finally does reach the air through a scratch in the coating, there is a marked tendency for the metal to resist ignition. This feature will be very important in electrical equipment where resistance to ignition under shorting conditions is a requirement.

Minimum Bath Control. The new anodic treatments will apply uniform coatings over a wide range of electrolyte composition so even with depletion of the bath satisfactory coatings are obtained. At least 20 sq ft per gal may be treated with the baths before adjustment must be made. Other baths require adjustments after less than 2 sq ft per gal have been treated.

Resistance to Some Chemicals. The new anodic coatings, on magnesium, show resistance to many acids and other chemicals so that new fields for magnesium are being opened up.

The disadvantages of these two treatments are as follows:

Special Racking. These magnesium anodizes like others require special racking. On the other hand, such racking has not affected the use of anodic coatings on other materials like aluminum.

Spalling of Coatings. These magnesium anodizes form a hard ceramic coating which will spall from the surface of the panel on the compression side. As indicated, earlier, certain paint materials can be absorbed into the coating and lock it in place, making it resistant to spalling even on compression. Vinyls are especially good in this respect. Furthermore, the thin magnesium anodizes may be used on products subject to flexing. With these coatings there is only a minor spalling problem.

Based on tests not yet completed, some conclusions can be drawn as to the differences between Dow #17 and HAE.

Most properties of the coatings are the same. Tests have shown an increase in corrosion resistance, resistance to humidity and excellent paint adhesion of the Dow #17 treatment. We would expect most of the coating characteristics to be the same for HAE.

HAE is considerably more abrasion resistant than Dow #17. This is especially true as the alloy content of the magnesium product increases.

Dow #17 offers more fire resistance. Tests of the type which might be run by Underwriters Laboratories to determine if magnesium is suitable as a case for electrical equipment reveal that the Dow #17 coating retards ignition significantly.

Dow #17 requires only one-quarter to one-fifth the current or time to apply that HAE requires. HAE requires about 1300 to 1400 amp-min/sq ft. Such differences in operating time and current should be reflected in lower costs in most job shop installations.

Heat given off during anodizing in a well-loaded tank requires cooling and possibly refrigeration of the HAE bath in order to maintain operating temperatures below 100 F. In the case of Dow #17 this heat at best will only maintain the operating temperature of around 160 F.

Iridite #15—The Iridite #15 has been developed by Allied Research Inc., of Baltimore. It is a room temperature treatment involving immersion of the part for from 1 to 2 min. On FS1 alloy it deposits a dark brown coating similar to the Dow #7 treatment. The short treatment time at room temperature makes it a very promising treatment. Paint adhesion and exterior corrosion data are not complete but they do indicate that the paint adhesion may not be as good as that obtained with Dow #7. Chloride ion contained in the bath necessitates very careful rinsing and this is probably the most critical step. If the chloride ion is not rinsed completely from the magnesium part, blistering of the paint films in high humidity tests may result. It has been demonstrated, however, that the Iridite coating can be rinsed adequately.

Phosphate Touch-up Treatment—Much finishing difficulty on magnesium has been experienced with chrome pickle touch-up treatment. To date, this is the only one on the approved list. Proper application of the chrome pickle treatment requires continuous wetting during application followed by adequate rinsing. Where the treatment is improperly applied, poorer paint adhesion may result than if no coating were applied. Most phosphate treatments do not form suitable paint bases on the magnesium alloy. The treatment listed here is one developed fairly recently by the Dow Metallurgical Laboratories. It is a good paint base, but is not quite as protective as the chromate containing baths. On the other hand. if paint adhesion can

Finish on this magnesium die cast steering column shroud gives part protection and pleasing appearance.

be maintained the paint will supply protection.

Bath Composition:
- Ammonium dihydrogen phosphate
- Sodium silicofluoride
- Ethyl or methyl alcohol
- Water

Operating Conditions:
- Time: ½ to 1 min.—dip or brush
- Temperature: Room

New Primers—In fabrication the best of the chemical treatments are removed from some areas. Generally, touch-up treatments are not as good paint bases as dip treatments. In order to insure good results on the whole part, adequate paint adhesion must be obtained on the bared areas. Primers which adhere to bare or poorly treated surfaces are a necessity.

Polyvinyl Butyral (non acid type). Several manufacturers have developed proprietary materials which do adhere to bare metal. These materials contain polyvinyl butyral as well as other resins. These types have excellent alkali resistance when baked. Paint adhesion is always improved with the use of a chemical treatment if that chemical treatment is not of the most protective type.

Wash Primers. Wash primers are also of the polyvinyl butyral type, but contain phosphoric acid. They have exhibited good adhesion to bare magnesium and excellent adhesion to chemically treated magnesium. In some cases, the wash primer has attacked the magnesium with the formation of hydrogen in the paint film showing up as blisters. Indications are that the acid and water content of the primer must be held to a low level with the acid being no higher than 1% in the spray gun.

Epichlorhydrin - Bisphenol Types. These primers are the most protective and best adhering for magnesium. In the past the fact that they had to be catalyst converted or baked was somewhat of a disadvantage. New air dry types are now available and being tested.

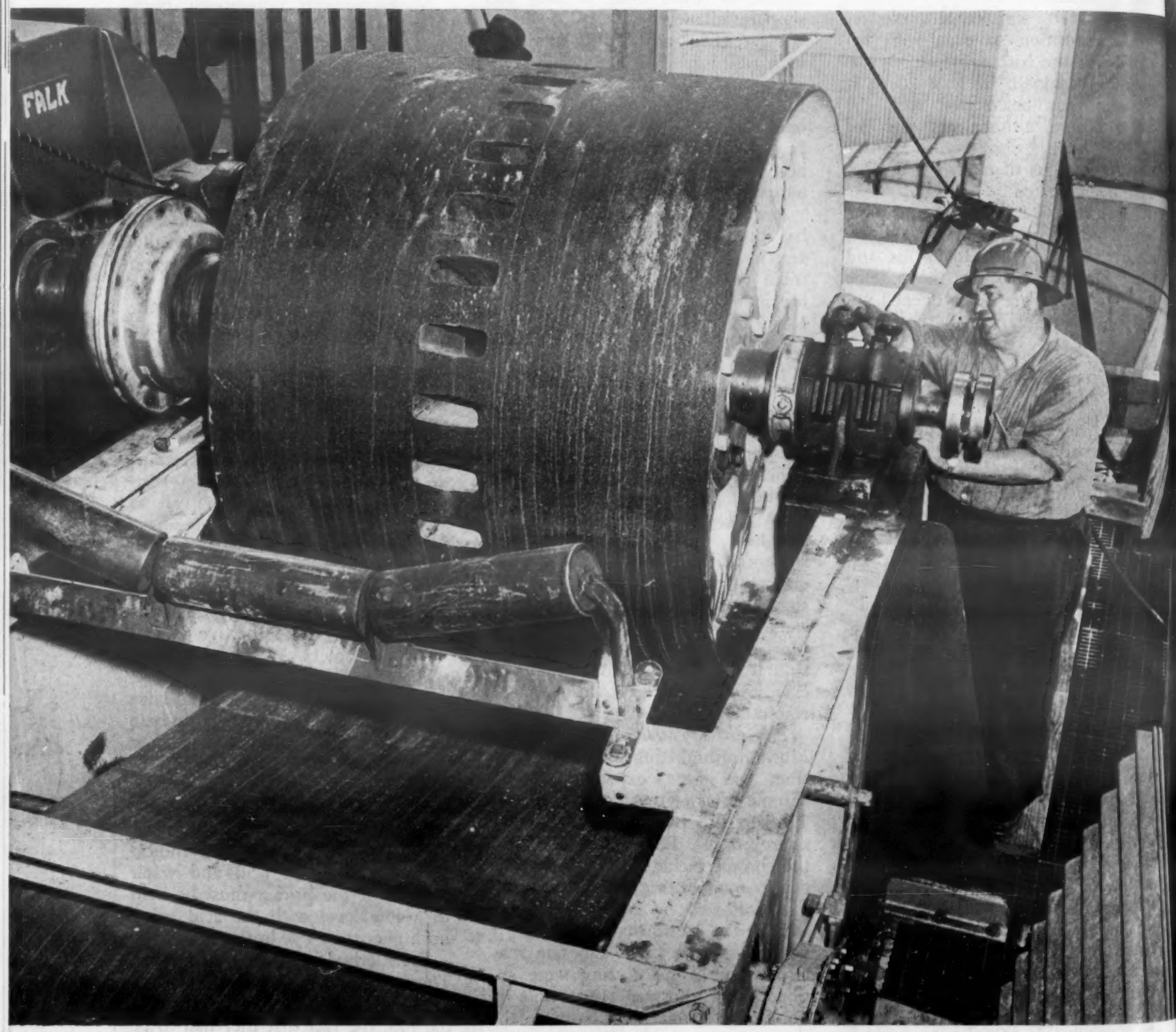
This article was adapted from a paper presented at the Ninth Annual Magnesium Association Meeting, Nov., 1953.

Materials at Work

Here is materials engineering in action . . .

New materials in their intended uses . . .

Older, basic materials in new applications . . .



NEW LAGGING MATERIAL IN MAGNETIC PULLEY This magnetic pulley, 60 in. in dia with a 48 in. face, was built by Stearns Magnetic, Inc., to remove tramp iron from the coal used at Oak Creek Power Station operated by the Wisconsin Electric Power Co. The removal of this material prevents damage to crushers and other equipment.

In developing this large sized unit, the manufacturer has applied a new type lagging in the form of a thin, tough strip of material with imbedded granules which is said to provide three times the traction of rubber lagging without belt wear, yet allow maximum use of the pulley's magnetic strength.

STAINLESS STEEL BELLOWS PUT "GIVE" IN WIND TUNNEL Huge stainless steel expansion joints, ranging from 5 to 28 ft in dia, have been fabricated by Solar Aircraft Co. for a wind tunnel being built in Cleveland by the National Advisory Committee for Aeronautics.

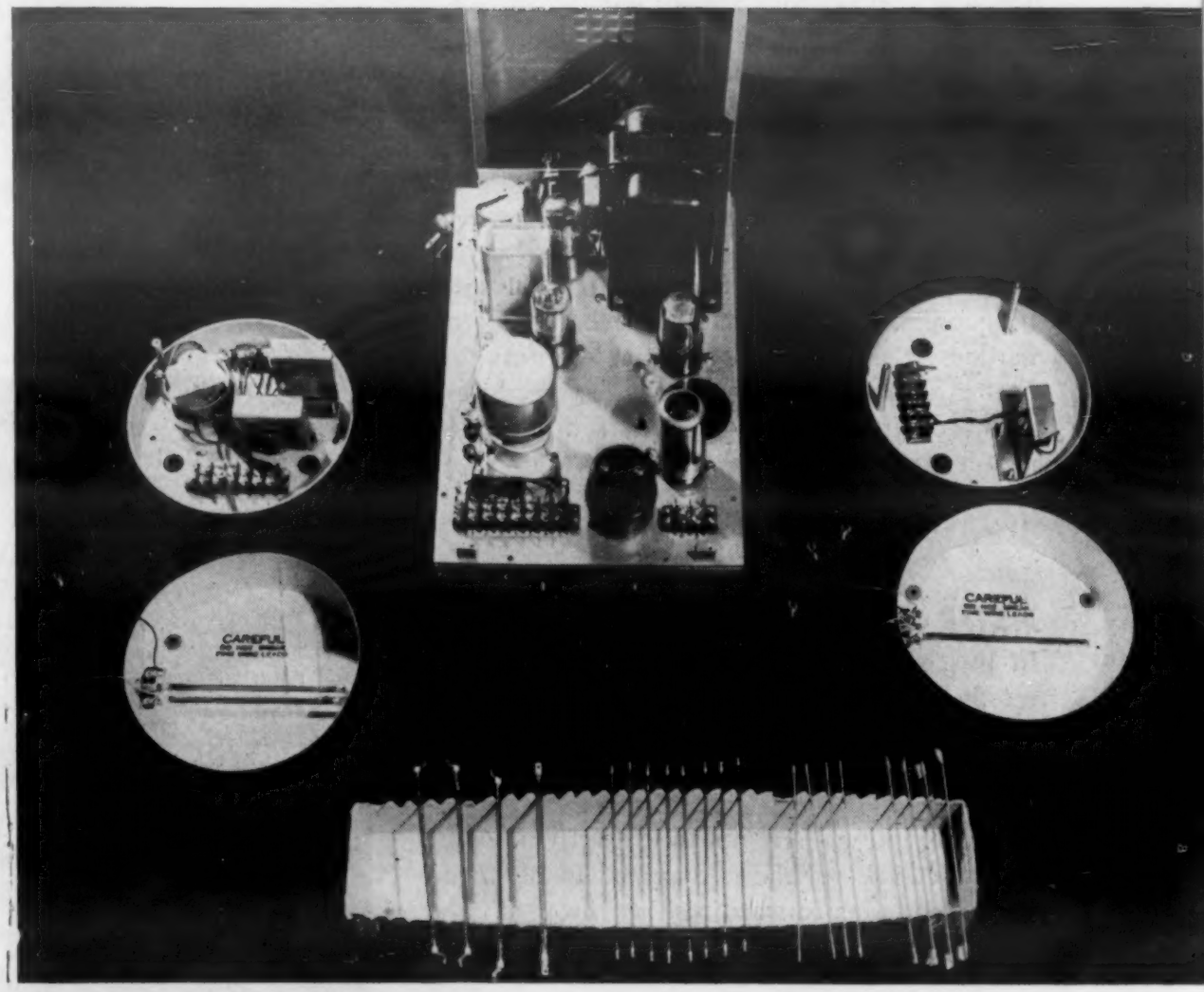
Special forming and welding techniques were employed in fabricating the bellows, which consist of stainsteel convolutions joined to carbon steel pipe ends. These bellows, when installed, allow for expansion and contraction and lend flexibility to tunnel when under stress of air pressure.

These large units are also made for use in refineries, food processing plants, petrochemical installations and other applications where temperature, pressure, corrosion, or erosion present problems in use of pipe.

NICKEL RODS USED IN BURGLAR-FIRE ALARM The good magnetostrictive property of nickel is utilized in this ultrasonic alarm system that can be actuated by any motion that disturbs waves sent out by the rods.

The rods are pure nickel, wrapped with copper wire. At the ends they are wrapped with a 50 nickel-50 iron alloy magnetic strip. The diaphragms that emit the vibrations contain two pairs of rods in the transducers and one pair of rods in the receiver. As the rods shrink and relax within the magnetic field, they vibrate the diaphragms which sends out waves at a rate of 19,200 per sec. These waves are picked up by a similar diaphragm with nickel rods which transmit the vibrations, by magnetostriction, as current to an amplifier and through it to a central station protective office.

Any interruption of the ultrasonic waves by a moving body or a mass of hot moving air sets off the alarm.



Materials at Work

BI-METALLIC TRANSITION PIECE ELIMINATES DOUBTFUL WELDS

Bi-metallic transition pieces, shown here prior to heat treatment, are manufactured by the M. W. Kellog Co., to eliminate the need for butt welding materials of widely differing coefficients of expansion in high temperature, high pressure steam systems.

The pieces have been used in connecting chrome-moly main steam piping with stainless steel throttle valves, since there is a difference of approximately 50% in the thermal coefficients of expansion of the two metals.

The pieces are manufactured by the patented Kelcaloy process by which austenitic steel is integrally bonded to a ferritic chrome-moly forging to provide connection ends of the desired metal, and a central transition bond of controlled axial length. Following casting, the transition pieces are machined and bored to proper dimensions and heat treated.

TITANIUM CARBIDE WEAR RINGS INCREASE LIFE OF SCARFING TIPS

After 192 hr of continuous service, the super-alloy tip shown at the left is no longer useable, while the one at the right has been protected by Kentanium, a cemented titanium carbide base composition developed by Kennametal Inc.

The carbide is one developed by that company for high temperature applications where wear and abrasion resistance are necessities. The combination of these properties with the light weight of the material is said to give up to 50 times longer service in some applications.

Among the applications for which the company states their Kentanium is successfully being used are flash trimming of welded steel tubes in tubular metal furniture, for hot spinning pipes, for pressure sleeves, balls for hot hardness testing, inserts for hot die forming, hot extrusion die inserts, tensile test heads and many others, including parts for restricted atomic energy processes.

WATER-COOLED GERMANIUM RECTIFIER

In this experimental water-cooled rectifier developed by Westinghouse Electric Corp., a wafer of germanium only 7/8 in. in dia and 0.015 in. thick delivers an average of 200 amps d.c. at 100 v.

While ratings are not yet exactly known, the peak back voltage is expected to be about 110 v and the forward voltage drop at 200 amps average (600 amps peak) about 0.8 v.

METALS COMBINED IN SPECIAL MOTORS AND GENERATORS

For a specific military application, Westinghouse Electric Corp. has designed and built a number of a.c. and d.c. motors and generators of different ratings which contain no iron except in the core.

The substitution of aluminum has been made in the frames which are fabricated by shielded-arc welding. The shafts are made of stainless steel.

In most cases the machines are as small as, and somewhat lighter than their conventional counterparts, and cannot be distinguished from them in appearance.

NEOPRENE PROTECTS FABRIC TUBING FROM ACID FUMES

Electrolytic copper refining tanks are covered by removable stainless steel hoods, from which connections are made to a fixed fume removal system to draw off the sulfuric acid vapors which are formed. When a tank is taken out of service for removal of the copper, its hood may be shifted to another tank which is ready to go back into service. Thus the hoods must fit all tanks, and to take care of minor variations in dimensions, the connections from hood to removal duct are made with flexible tubing.

Neoprene-coated cotton duck, supported by a wire helix is now replacing flexible stainless steel hose for handling these corrosive vapors at one large copper refinery. The use of this material conserves the critical nickel bearing alloys previously used.

Manufactured by Flexible Tubing Corp., the tubing is said to be light in weight, highly flexible, and the heavy coating of neoprene resists attack by the acid fumes. The flexibility and abrasion resistance of the coating is also said to enable it to give long service despite frequent making and breaking of joints.

Materials at Work

PLASTIC TAIL AIDS PERFORMANCE OF SPEEDBOAT

The Fiberlay tail shown being installed on Seattle's Slo-Mo-Shun IV was designed to create a suction to starboard to counteract the pull to port created by the propeller torque.

Fabricated by Pacific Plastics Co., the tail was made of glass fiber reinforced polyester resins to gain the advantages of strength, light weight, moldability and low cost tooling. The tail was made in two sections, one side at a time. After each section was released from the pattern and trimmed, it was laminated together with Fiberglas mat and polyester resins.

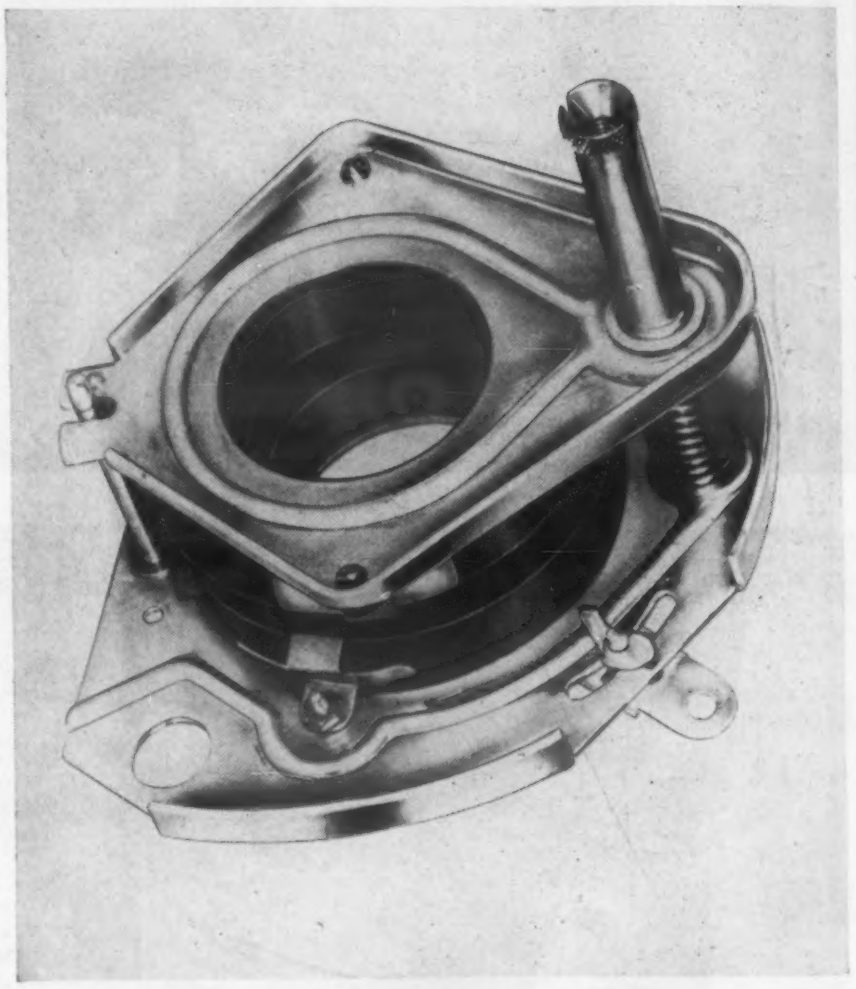
The designing of the tail was based on the aerodynamic principle used in airplane wing construction. The suction or lift created on one side of the tail offsets the propeller torque, allowing the boat to run a straight course with a straight rudder.

CERAMIC MAGNET AIDS TV FOCUSING

Magnadur, the nonmetallic permanent magnet material marketed by the Ferroxcube Corp. of America, is used in the form of two toroidal ring magnets in a double lens system in television focusing devices. The system is focused by adjustment of the relative position of the two toroids, and the use of the new material is said to reduce stray fields to a minimum and to provide a symmetrical field of maximum sharpness and spot symmetry.

According to the company, one of the important features of Magnadur is that it does not contain nickel, cobalt, tungsten, chromium, or any other critical materials. It consists of barium carbonate and iron oxide, which are mixed, pressed or extruded into a suitable shape, and then sintered. The resultant product is said to be a hard, rather brittle substance having a high permanent-magnetic quality.

Magnetically the most striking characteristics of the material are its high coercive force of 1600 oersteds and the nearly unity slope of the demagnetization curve. It therefore has a high resistance to demagnetizing forces and good stability. It also has an electrical resistivity greater than 10^6 ohm-cm.

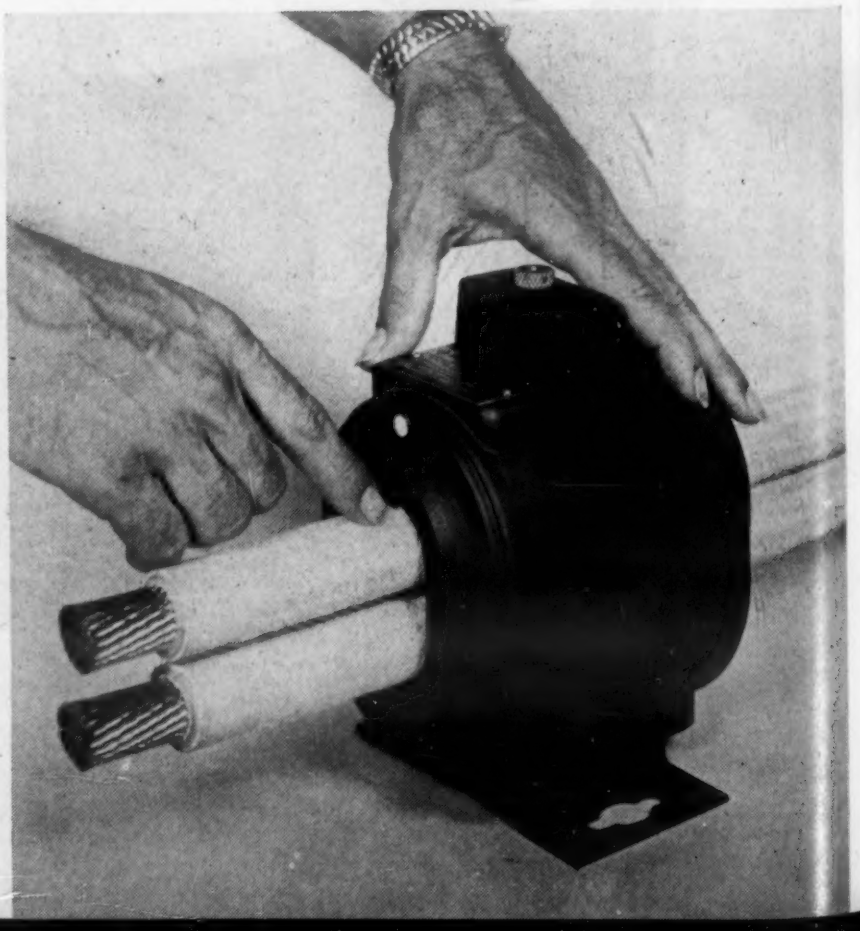


PLASTIC SERVES AS INSULATION, SUPPORT AND CASING IN METERING TRANSFORMER

High dimensional stability is claimed for the molded plastic casing of a "thru-type" current transformer produced by Allis-Chalmers. This is an important factor since any shifting in the material will destroy the accuracy of the metering action of the device.

Designed for indoor or outdoor service, the transformer is molded in thermosetting epoxy resin which possesses an inherent toughness, promoting long life and making the unit weather resistant.

The transformer's elliptically shaped window accommodates two 500-MCM stranded conductors with 600 v insulation. The unit is said to have conventional accuracy for light burden metering.



Iron and Steels

Nonferrous Metals

Nonmetallic Materials

Parts and Forms

Finishes and Coatings

Annual Materials Engineering Review and Forecast

MATERIALS & METHODS
Manual No. 101

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and applications.

JANUARY 1954

by T. C. DuMOND, Editor, Materials & Methods

An appraisal of the past year's developments in engineering materials reveals some of the changes in the use of materials that probably will be forthcoming in 1954. Expected are sharp drops in prices of some basic materials; more general use of extrusions; keener competition between both old and new materials and forms; and wider use of forms that can be produced to close tolerances and high finish.

Introduction

In trying to forecast future activity in the field of materials engineering, at least the activity anticipated during 1954, we shall use two points upon which to focus our sights. First, and safest, is the general trend as demonstrated by developments in, and uses of, materials during 1953. In addition, some of our forecasting will be done with complete acceptance of the views of some competent observers who believe that the recent drop in business activity has been in the nature of a psychological depression. That depression is over, these same observers say.

First, let's review briefly some of the economic factors which will have some effect upon materials for the next year, and perhaps longer.

As you will remember, materials controls were still going strong at the start of 1953. Later in the year, practically all stringent controls were dropped, even those governing the use of nickel. In the case of most materials, supplies became more than adequate in the latter part of the year. In fact, steel production dropped to below the 100% of capacity mark for the first extended period in many years.

Of all the engineering materials, nickel is still the only one in general use that is in such scarce supply that it cannot meet the needs of the country. Even in the case of nickel, enough of that metal was released late in 1953 to permit a somewhat slow reversal of the trend away from alloy steels. During the latter months, many companies that had been making considerable use of low carbon steels and boron steels abandoned these for many products and again started using some of the milder alloys. Some producers are now offering unlimited quantities of chromium-nickel stainless steels.

In other materials, at least those in common use, the supply situation was also improved, although some small shortages existed. The newer highly publicized metallic materials are still not available for general use. Nonmetallic materials continued to rise in usage throughout the year, particularly in engineering applications.

Two factors contributed to the easing of the materials supply situation. First, of course, was the signing of the Korean truce and a general reduction in military production. Secondly, there was a period of caution on the part of consumers as well as producers of civilian goods. Some slight reduction in employment occurred, but employment is still at its highest point in the history of the country.

As a result of the general reduction in business activity there has been a slowing down of the rising prices in materials. In fact, some materials have shown a slight drop in price. On the other hand, some of the more scarce elements are still continuing to increase in cost. For example, cobalt recently went up in price to put the cost of high temperature materials at a new high.

Labor costs continue to rise, so industry started paying more attention to means of reducing the other costs that enter into the final prices of their products. Among the methods being employed for cost reduction are changes in forms of materials used, shifts from one material to another and the adoption of methods that will either result in less machining and finishing, or reduce scrap loss, or perhaps both.

Paced largely by the aircraft industry, there is a race towards machines and other equipment that are smaller, lighter and capable of long service with little or no maintenance even under conditions that could hardly be considered favorable. The demand for components meeting these conditions now extends throughout industry, from office machines to locomotives and embraces most types of products in between.

A good example of this trend can be found in the developments announced during the last few months in the electric motor industry. Most manufacturers of motors have announced some similar changes, so the results of the engineering of one company will serve to illustrate the trend. In this case, the size and weight of the motors have been reduced and the service life extended. Today a 5-hp motor is about the same size as a 2-hp motor of the recent past. The size reduction has also reduced the weight per horsepower. The weight of a new 1-hp is between 48 and 58 lb as compared to 67 to 84 lb for the previous motors of the same rating. It is interesting to notice in passing that about 40 years ago a 1-hp electric motor weighed about 200 lb.

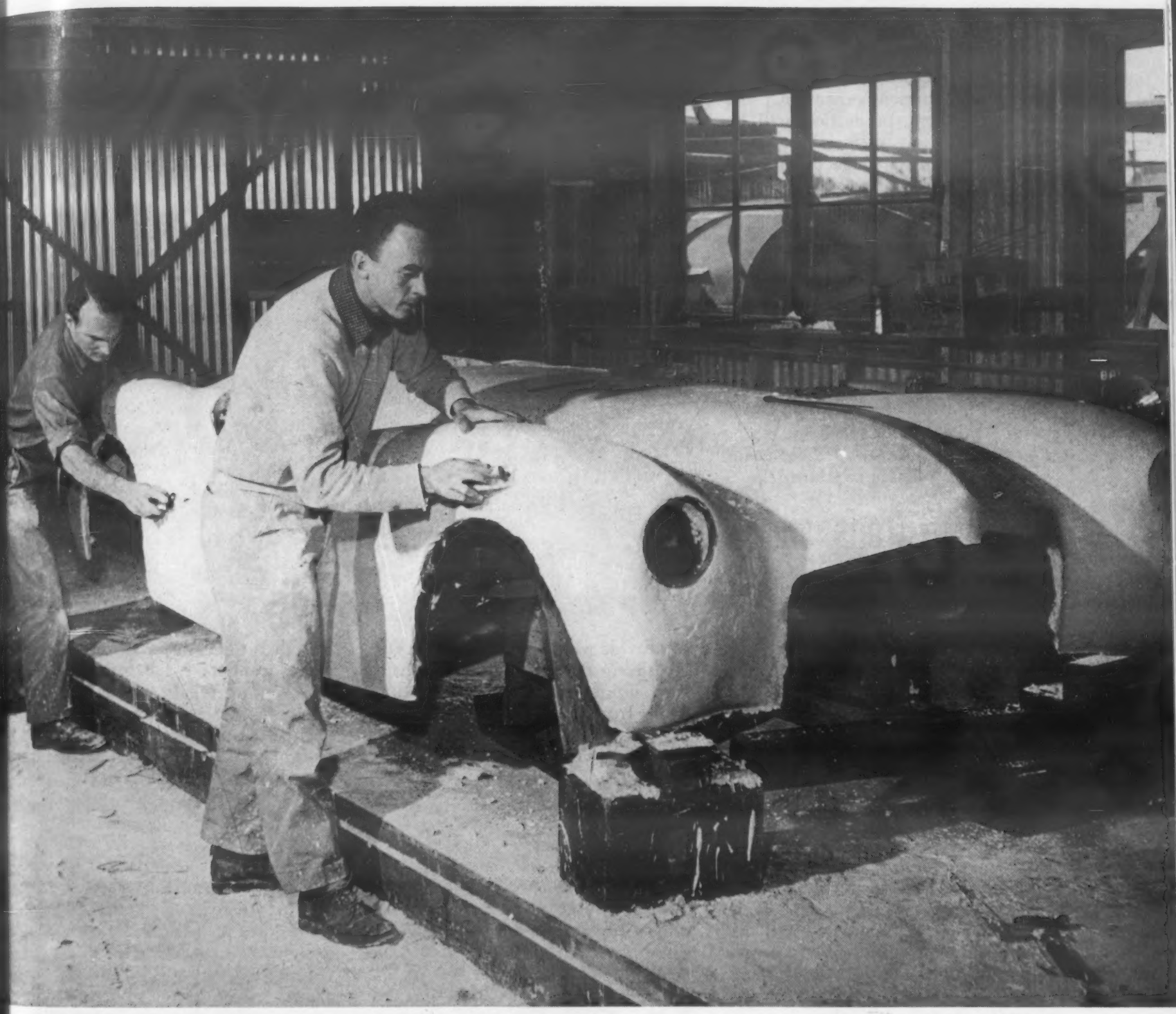
Both size and weight reductions can be attributed to the engineering which took advantage of the properties offered by a wide selection of materials. The new motors use die cast aluminum rotors, cast iron frames, polyester resin insulation, plastics fans and new lubricants which have exceptionally long service life under widely varying service conditions. The motors are normally copper-wound, but so designed that aluminum can be used whenever necessary or desirable.

The search still continues for materials that will resist high temperatures. The problems are many, varied and complex. Some engineers seek materials that will withstand high temperatures for extremely short periods as might be the case in rockets, others for periods extending into minutes as in guided missiles, still others for long continued usage as in aircraft engines, chemical equipment and other products. There will be a continued fight between metals and alloys and nonmetallic materials and coatings for the tough applications.

What's Coming

A general increase in competition throughout all phases of industry will mark the coming year. This will be just as true of industrial products

Review and Forecast



During 1953, production models of automobiles with reinforced plastics bodies became a reality. Indications are that even more auto makers will use plastics bodies in 1954. Here workers are putting the finishing touches to the lay-up of a special sports car body.

as it is of consumer goods. Practically every time there is a new demand for less expensive or better products, one of the first places the engineers must look is in the direction of the materials they use. If the materials themselves are satisfactory from both a service and cost standpoint, the engineers must look further and see if they are being used in their most economical form, assembled by the best and/or least expensive methods, and that there is no waste motion or cost in their finishing.

As each material group is discussed more in detail later in this review, we shall discuss some of the individual developments and explore more fully the possibilities for 1954. However, there are some general trends which should become stronger as the months progress. For example, the use of extrusions will become more general in all materials. Both hot and cold extruding of steel are now relatively close to being perfected. Shell molding, powder metallurgy, investment casting and other methods of making parts to close tolerances with good finishes will attract more attention. Despite the resurgance of the alloy steels, there will be more and more pressure—cost wise—to use the carbon and low alloy steels and make them suit the application by proper treatments.

Too, there will be considerable shifting back and forth among materials. Some of the newer materials will gain new markets and applications, but at the same time, some of the older and time honored materials will regain applications which might have seemed lost to them a year or two ago.

Industry in general will have to wait much longer than just 1954 before it can try to evaluate titanium and some of the other new metals. Total production of titanium, for in-

stance, is much less than the demand that exists in the aircraft industry alone. The situation is likely to remain that way for some years, for according to present expansion plans of the industry, production will be about 25,000 tons of metal a year by 1956. Estimates are that the aircraft industry alone will take more than 22,000 tons a year.

There are likely to be rather sharp reductions in the prices charged for some of the basic materials as the year develops. Some of the price drops will come as a result of more efficient production methods such as extruding and continuous casting. Others will come through the absorption of freight charges, the elimination of some charges for extras and other concessions. Drop in the use of some others will also cause price reductions.

Most observers predict that the total volume of business in 1954 will be within a few percentage points of the marks recorded during the past year. Since business during 1953 was at record levels in most industries, that should mean continued high activity and a continued demand for materials of all types. With most materials producers geared to an extremely high output, the small drop in business is just sufficient to relieve the pressures which have created scarcities and kept prices at their highest points.

Now let's look at what's happened and what is expected in the major materials and in some of the methods used to process them.

Irons and Steels

While there have been some changes in the steel picture as far as types and compositions are concerned, much of the past development has been—and future development is likely to be—in the nature of changes in production and in methods of using steel.

For the past few years there has been some discussion of steels with almost unbelievably high strengths. Strengths in the nature of 300,000 psi are now being discussed. It is likely that such strengths will be achieved and prove entirely satisfactory for the intended uses. There is a demand for these steels in the aircraft industry where there is some hope of using them to replace light metals in many applications.

As airplanes grow larger and heavier, materials must be provided to take the teriffic stresses involved and to absorb the tremendous shocks which occur in landing and straining for take-offs under full load. Currently steels have been developed which have strengths in the range mentioned, but at present there are a few problems which must be solved. It appears likely that if the problems of notch sensitivity and brittleness are not solved this year, they will be soon thereafter.

It is the hope of aircraft engineers that they can have steels of such high strength that they can be used in extremely thin sections so as to provide parts and components that are strong enough, but are, perhaps, even lighter than the same sections made from any of the light metals. Here is one instance where steels might recover some of the ground lost to other metals during the rapid growth of the aircraft industry.

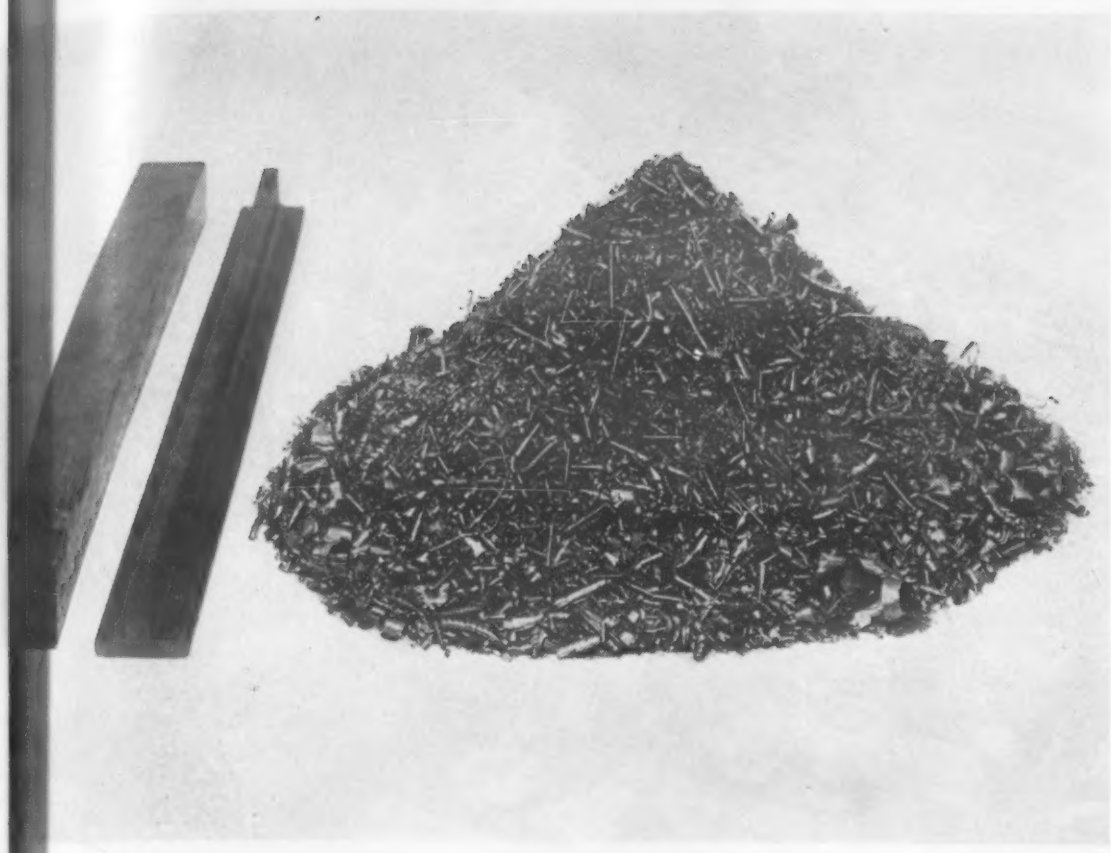
Although 18:8 stainless steels are now much more readily available than they were six months ago, research continues to seek satisfactory substitutes. One steel which has proved itself capable of replacing the chromium-nickel stainlesses, at least in railway car and tractor trailers applications is known as T-RC (Trailer-Railway Car). The steel is a variation of some of the chromium-manganese stainless steels. TRC contains 16% manganese, 16 chromium and 1 nickel. Those who have used the steel report that while it does not duplicate the 18:8 stainless steels in all respects, it does serve admirably in the uses to which it has been put.

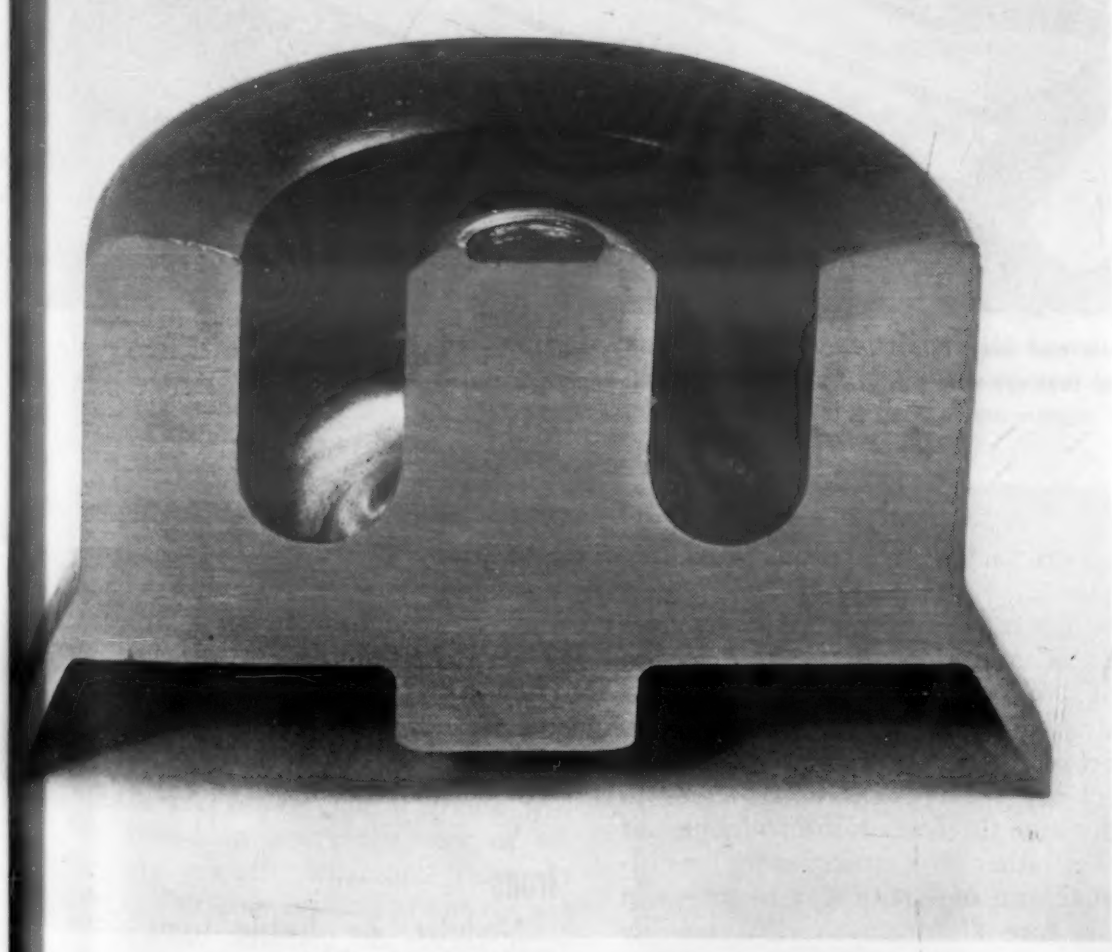
Others who are working on the development of chromium-manganese stainless steels believe that for best results, a stainless steel in which manganese largely replaces nickel must contain at least 3.5% nickel. One such steel which serves as an alternate for 18:8 contains 18% chromium, 4 nickel and 6 manganese.

Manganese stainless steels are not entirely new, for much work was done with them about 20 years ago. At that time steels of this nature were abandoned due to the difficulties encountered in producing them. Now, there is a feeling that developmental work will continue remembering that even though restrictions on the uses of nickel have been eased, there still is not enough nickel available to permit its unlimited use.

For those applications where the special properties of stainless steels and other high alloy steels are not needed, there is a determined effort to use the plain carbon steels. During the shortages of alloy steels during the Korean War, many steel producers taught their customers that the carbon steels, through proper design and treatments, could be used in many places where alloy steels were once considered to be essential. With price competition a likely factor during the coming year, there will be continued pressure towards the use of less costly materials.

During the period of the Korean War, there were many predictions that the boron steels would remain as important steels, after war-created scarcities had passed. Those predictions seem to have been faulty. Difficulties in meeting specifications in the producing mills led to an attempt to widen the limits of acceptability for the steels. Many consumers could not, or did not want to tolerate such wide limits and therefore returned to low alloy steels or the





Users of steels are adopting new extrusion processes as a means of lowering costs and saving time. On the top is shown a hot extruded section along with a bar which would have been necessary had the same section been machined from the solid. The chips represent the metal saved by extruding. Below is a cold extruded shape in steel. The thin wall flanges are shaped in combination with integral top and bottom inside studs. Flanges and studs could be of any thickness, length or angle.

straight carbon steels.

The extruding of steel which has been talked about for several years is now ready to burst into full bloom as a production method. Cold extruding has been used for a number of years on various cylindrical items for the military. Now both cold and hot extruding are being used for products of less regular shape.

Cold extruding is generally confined to making complete parts, but hot extruding is being used to produce solid bar shapes as well as tubing. The shapes produced as hot extrusions are similar to those extruded in aluminum and magnesium. Long extrusions are produced and then pieces are cut off to the desired size for their intended use.

Potentialities of the hot extruding of steel are shown by an application recently announced on the West Coast. A piece used on military aircraft was formerly made as a casting at a cost of $29.40. When the part was converted to an extrusion, the price was reduced to $8.90. Only drilling was required on the extruded piece. Extruding has been used thus far to make parts of SAE 8630 and 8632 alloy steels and Types 434, 410 and 431 stainless steels.

With die costs ranging from $200 to $500 for simple shapes, those responsible for the techniques used to produce the part referred to believe that hot extruding can be practicable for producing as little as 50 ft of special alloy. Thus far, metal has been extruded at temperatures up to 2200 F. Extruded bars 30-ft in length are said to have excellent surfaces and are well within tolerances.

Because extruding provides some of the advantages of forging, as far as its effect upon steel is concerned, some engineers believed that extruding might permit the use of lower grade steels without loss of properties.

It is to be expected that the continuous casting of steel will soon be an accomplished fact. Experiments have been conducted for several years using modifications of the methods which are now becoming standard in brass mills. The actual process is somewhat more expensive than present methods, but the yield of usable steels is about 10% greater. Billets are cast by the new process, rather than ingots which are poured in the standard steel mill.

Another change in production techniques of steel is considered likely to

Automobiles are carrying more and more aluminum and magnesium in an attempt to hold weight down despite the additional equipment built into the cars. The 64 pounds of light metal castings used on a 1954 Chrysler sedan are estimated to save 183 lb over the same parts made of heavier metals.

have a beneficial effect upon the steel produced. Considerable investigation is being conducted into the use of electric furnaces to produce carbon steel. Advocates of the process believe that steel would be less expensive and also, because the electric furnace permits closer control over sulfur content, that better grades could be produced for welding and deep drawing. It is possible that some of the steel mills of the future will combine continuous casting and electric furnace melting. That combination might also make economical smaller steel mills in areas that are remote from the major steel producing centers.

Currently, investigations are being conducted into the uses of cerium and the rare earths as grain refining agents in steels. Misch metals have been used in boron steels with interesting results. For example, 3 to 5 lb of Misch metal added to a ton of 8640 steel increased the impact strength from about 30ft-lb up to between 40 and 50 ft-lb. Researchers say that Misch metal serves to promote the formation of globules of slag rather than stringers. The ultimate aim of attaining a better grain structure is to improve workability of steels.

Some users of steels are finding that higher endurance limits can be obtained by nitriding rather than by shot peening, which has become widely used.

In making comparisons on crankshafts, two steels were used with two completely different treatments. One SAE 1046 steel was induction hardened and the fillets were shot peened, the other SAE 4140 steel nitrided. The first combination achieved an endurance limit of about 62,000 psi; the second is over 100,000 psi. Based on these results, other investigations will be undertaken.

Irons

Nodular, or ductile irons have made considerable progress in finding their proper niche in the industrial sphere. One illustration of what is happening is also somewhat typical of the shifts from one materials group to another that are likely to become more frequent as competition increases. In one aircraft application, nodular iron is replacing

aluminum for the manufacture of motor mounting rings. Success of this application has given rise to the hopes of some engineers for a nodular steel—if such material is possible.

There have been several interesting developments in the field of iron powders such as are used in making parts by powder metallurgy methods. Most important is the development of iron powders which, when compacted and sintered, have excellent ductility and which can be used extensively for such parts as gears and cams. Properties of the finished parts are comparable to those made of mild steel; in other words, they can be used in applications where pressures are as high as 70,000 psi. Ductile powder metal parts should lead to an even greater use in the future.

Iron powder rotating bands for artillery shells became a reality during 1952, after several years of discussion and investigation. However, production was not great due to the lessened demand for ammunition. The important element about this development is that in cases of future emergency, when copper might again be critically short, here is a proved way of saving copper.

Nonferrous Metals

Activity in the nonferrous metals field follows rather closely that taking place in irons and steels. There is a universal desire, it seems, to either attain light weight, without significant sacrifice in strength, or permit higher operating temperatures. In some cases, both objectives are sought.

Although those materials which are fair game for the glamour treatment have received the most attention, progress in the more common metals has not been any less important. In aluminum and magnesium, attempts are being made to improve their workability or to increase their temperature ranges, or otherwise make small but vital improvements.

First, let us look at the elements that have most recently been in the limelight:

Titanium and Zirconium

At this point it appears that there will be too little to meet military needs even though the producers are considering greatly expanded plants. There are hopes that methods will be found to lower the cost of reducing metallic titanium from its ores. For this reason, producers are somewhat reluctant to spend huge sums building new plants, when the threat of obsolescence is so great.

Needs of the aircraft and military users of titanium indicate a consumption of 25,000 tons during 1954. Other statements in recent congressional hearings have claimed existing needs for many times that tonnage. Regardless of the actual amount of titanium produced during the coming year, it is reasonable to believe that there will be little, if any, of the metal remaining for civilian uses.

Eventually, there will be a great deal of titanium used in marine applications even if the cost remains high. The excellent corrosion resistance of titanium makes it withstand exposure to salt water and marine atmospheres and outlive most other materials.

Attempts are being made to have standard designations developed for titanium alloys so that users will not be confused by the grade names or numbers of individual producers. This in itself is an important step forward and indicates the increasing maturity of the industry.

During the last year, the first alpha aloy of titanium was announced. The alloy consisting of titanium, aluminum and tin is readily weldable and

This impeller for turbo-charger equipment was made by shell molding. Shell molds were used for the outer mold and for cores. Shell molding is said to have reduced costs by two-thirds over the plaster mold casting method previously used. The shape could also have been made by die casting except that a special high strength alloy needed for the part could not be die cast.

has workability approaching that of commercially pure titanium.

The future of zirconium is not so clear. Until now practically the only use for zirconium has been in the atomic energy program. Claims have been made that zirconium will be used extensively as a deoxidizer for steel and for many applications dealing with severely corrosive media. Skeptics point out that other metals can do these jobs equally well or better and at considerably lower cost.

Molybdenum

Great hopes still dwell on molybdenum as the high temperature material of the future. It is true that molybdenum has excellent strength at 1800 F, but currently there are two drawbacks preventing its use. Alloys of molybdenum that are sufficiently ductile have not yet been perfected. The other problem is somewhat more difficult. Molybdenum will vaporize at high temperatures. For this reason, a coating must be used on the metal. The necessary coating, which has not yet been found, must be free of porosity because vaporized molybdenum can escape through minute openings and eventually leave only the shell of coating. Some experiments have been tried in which the molybdenum is clad with nickel or nickel alloys. The clad material holds some promise.

Nickel

The big immediate news about nickel is that most restrictions on its use have been withtdrawn. Whether or not the supply situation gets better or worse remains to be seen. As soon as it became obvious that there were to be no restrictions, many former users of stainless and alloy steels again clamored for them. At the same time, there are other actual or impending developments which could result in a tighter supply situation.

One development which came into the open last year could result in a demand for vast quantities of nickel. The development is electroless nickel plating. The process was announced after many years of research and pilot operations. Although electroless nickel plating is being used on a number of small parts, it can be used just as easily on parts as large as railway tank cars. If any large scale demand for the plating of huge objects develops, a shortage of nickel could again develop.

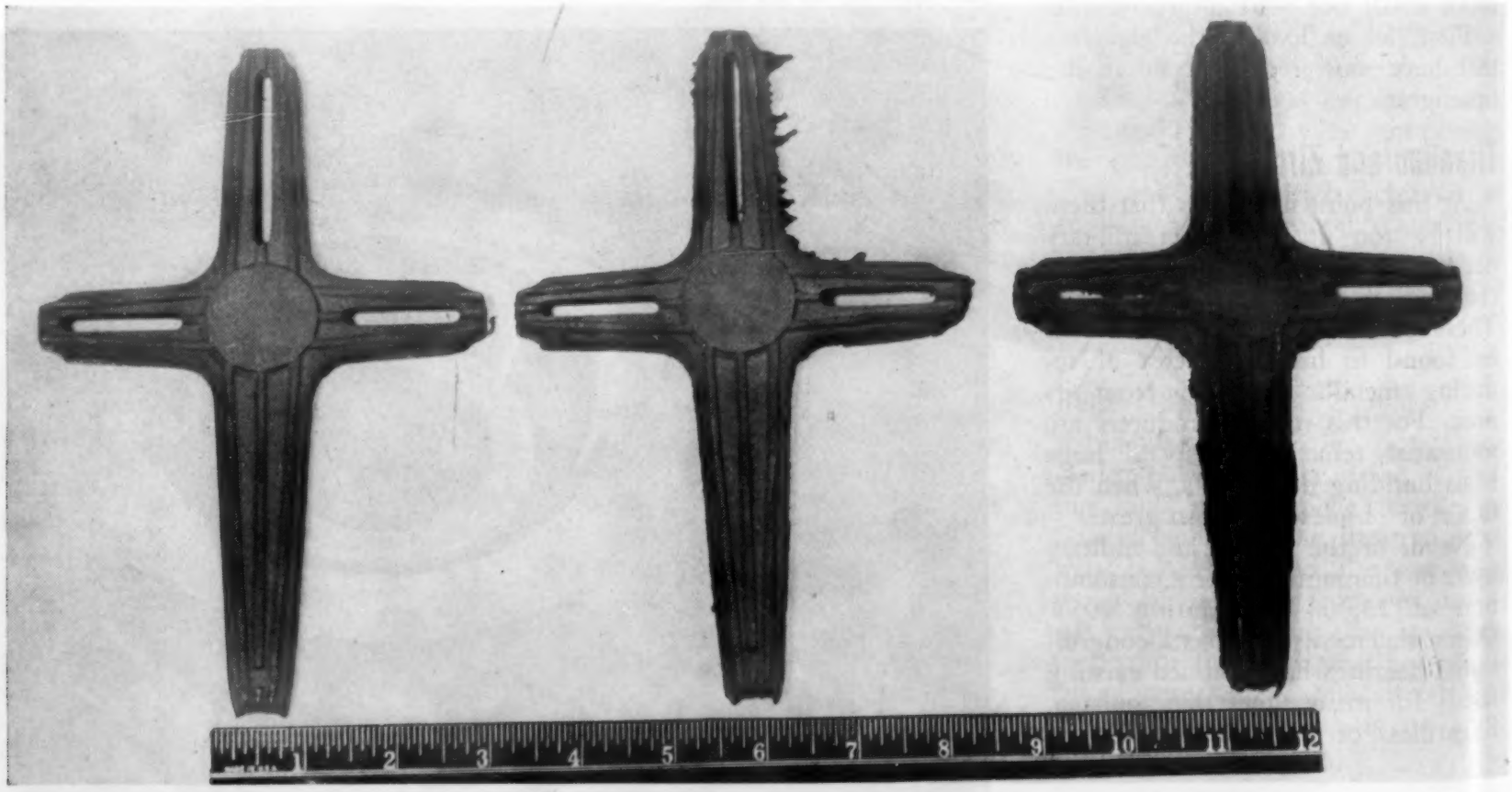
Reports are current that a ceramic coating for nickel is nearing the stage where it can be applied commercially. If this is true, nickel will be needed in immense quantities for applications involving temperatures of from 1600 to 1800 F. That temperature range is the one causing most difficulty today. Nickel has the required strength in the 1600 to 1800 F temperature range, but is prone to oxidize. A ceramic coating could overcome that difficulty. Of course, ceramic coatings have been used for some time on stainless steels and other alloy steels to increase their service life at high temperatures.

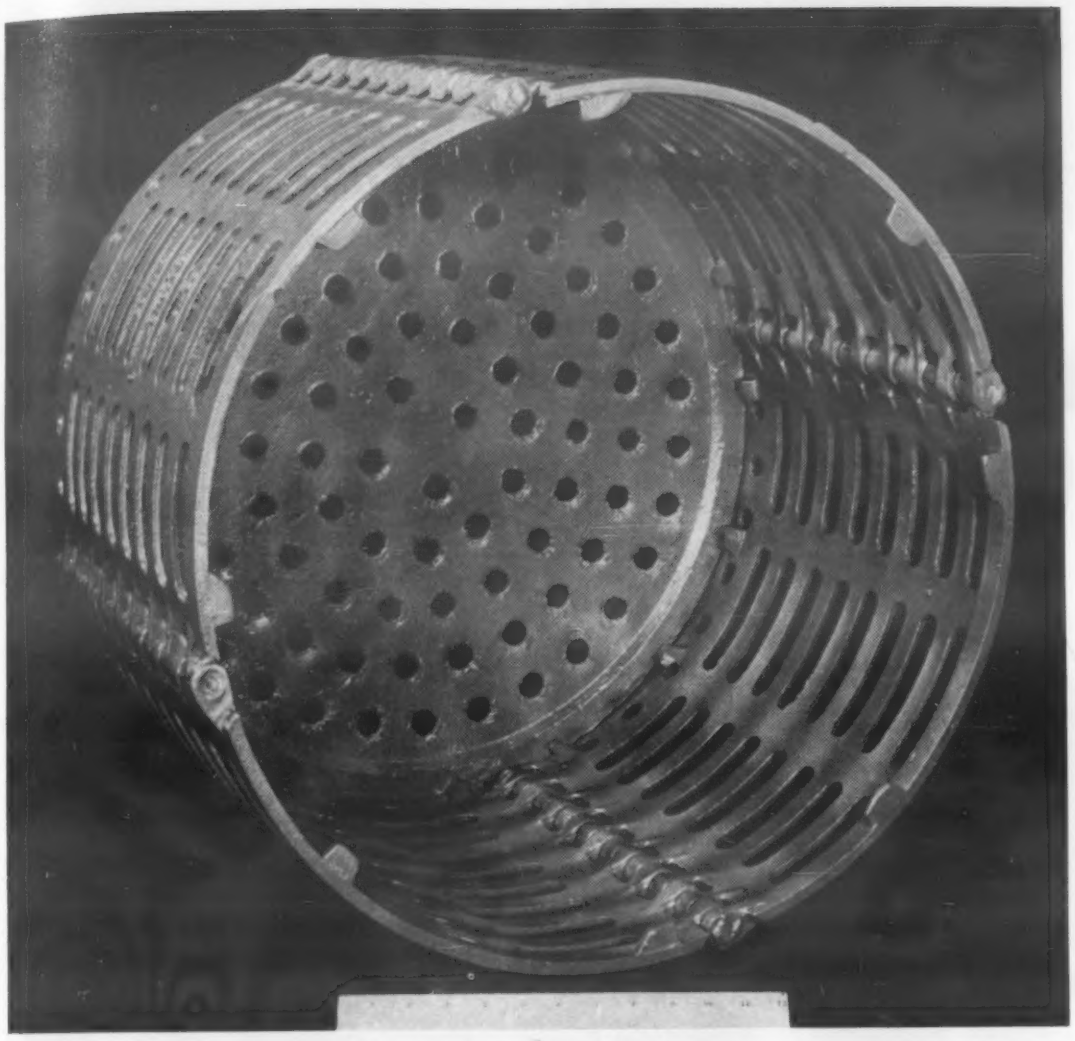
Copper

Now that supplies of copper are more than adequate, there will be considerable effort to help copper regain some of the ground it lost during the recent period of scarcity. There are many applications where copper has been considered more satisfactory than the replacement material. However, in many electrical applications aluminum has taken a firm hold. In other cases, products are so designed as to permit a shuttling between copper and aluminum depending upon cost, supply or any other condition.

There has been little impetus to develop new copper alloys because of the shortages which existed until a few months ago; although, prior to the easing of the supply situation, there was considerable investigation

During the last year two new developments extended the range of usefulness of magnesium. The lightest of commercial metals can now be formed by both shell molding and impact extruding. The two parts at the left of this illustration were made by shell molding while the third is a conventional sand casting. The improved surface and detail is obvious.





Ceramic coatings have received considerable attention as a means of adding to the life of metals used in jet engine parts. The same combination is also finding application for more prosaic parts such as this heat treating basket. The ceramic coatings protect the base metal from repeated exposure to extreme heat. In this case, the base metal is Type 330 stainless steel.

of various alloys in attempts to save copper or nickel or both.

There is a constant demand for new and better materials that can serve as electrically-conductive springs. One such material is a beryllium copper. Its properties fall somewhere in between those of the highly conductive alloys and those intended for mechanical parts.

An alloy emerging from the experimental phase has somewhat similar properties and uses. The copper-base material contains about 10% nickel, 1.5 silicon and 4.0 aluminum. The new alloy is said to be easily formed in the solution-treated condition and can be hardened by aging to have a proportional limit of 85,000 psi, yield strength of 120,000 psi, tensile strength of 140,000 psi, elongation of 8% and a modulus of elasticity in tension of 19 million psi. One possible use of the new alloy is in making electrical contact springs for equipment such as business machines.

Aluminum and Magnesium

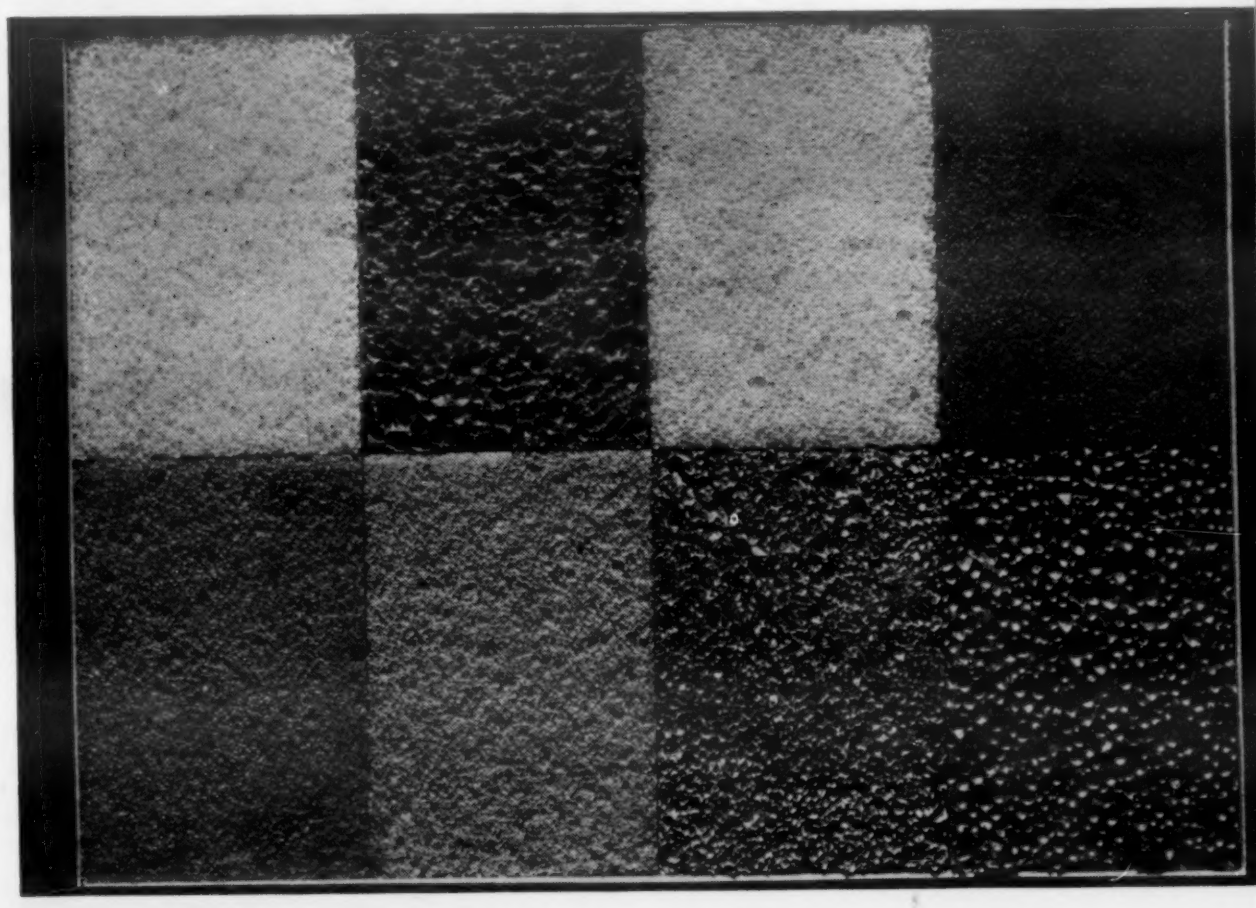
During 1953 there was relatively little activity in the older light metals, at least as far as new materials developments were concerned. On the other hand, there was increased use of these materials and much research was directed toward making the metals perform under more difficult conditions.

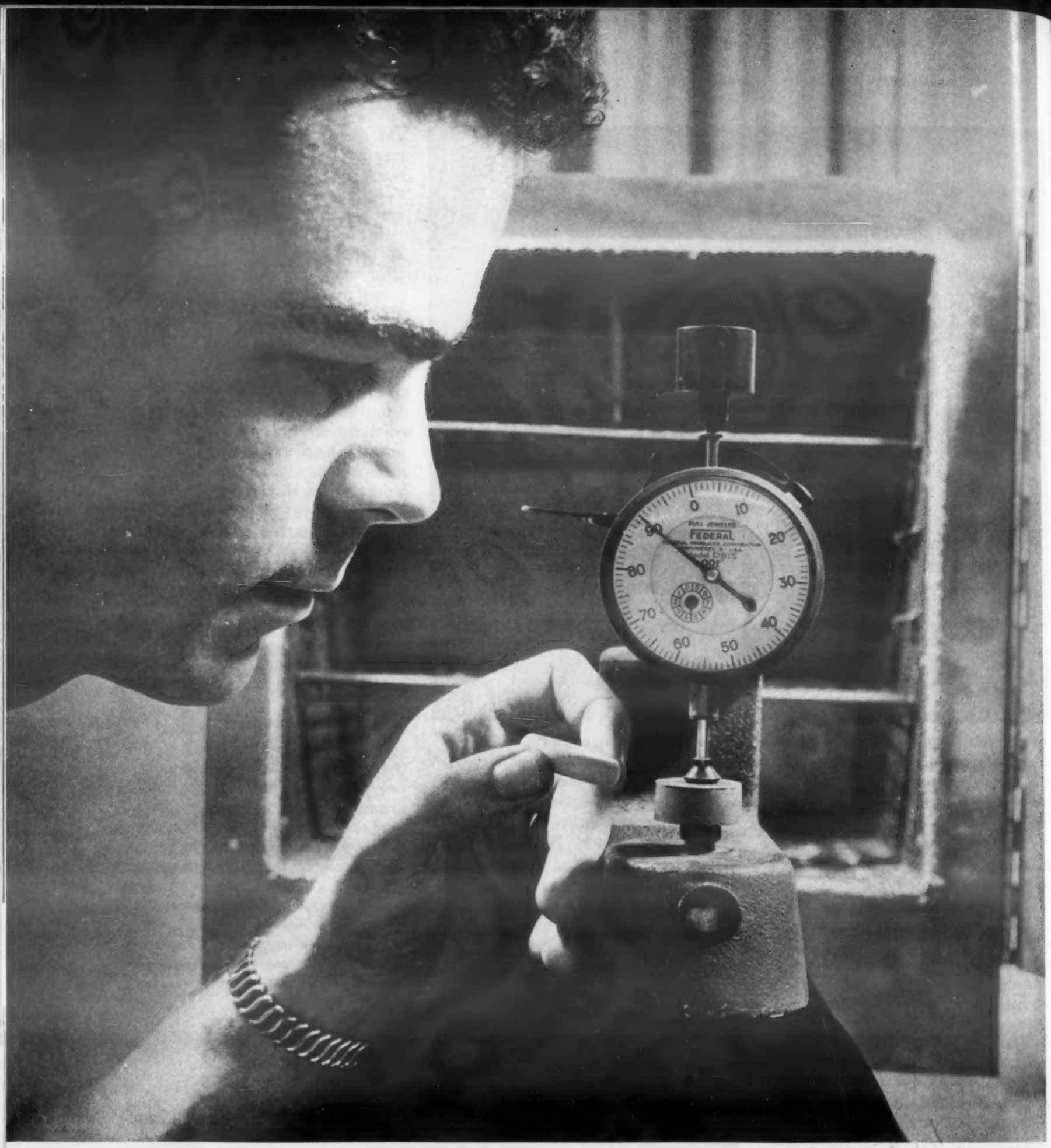
In the case of aluminum, there has been considerable interest in an alloy made from sintered aluminum powder. This Swiss development, known as SAP, is intended to provide a strong, high-temperature material. The Swiss product is said to be capable of operating at temperatures up to 800 F. SAP is produced from fine aluminum powder by a combination of cold pressing, hot pressing and extruding. From raw material shapes, SAP can be further worked into sheets, shapes or forgings.

During the last year experiments on similar alloys have been conducted in this country. Considerable quantities of alloys have been made and used on pilot operation scales. Sometime during 1954, results of these tests will probably be revealed. One definite point has been established and that is alloys made in this manner will be much more expensive than the normal wrought or cast alloys as well as being more costly than the usual aluminum powder parts made by ordinary powder metallurgy methods.

A more widespread use of aluminum in diesel engines might be forecast by use of that metal in cylinder heads. In a recent application, aluminum heads 7 in. in diameter and 4

Plastics, rubber and silicone foams continue to find a place in industry. This illustration shows the range of densities which can be created in a foamable plastics material by slight alteration in the formula.





There were a number of new silicone developments in 1953, among them this low compression set silicone rubber. Here it is being compared with general purpose silicone rubber.

in. deep, weighing about 25 lb were made as investment castings.

Too, die cast aluminum rotors are being used in more and more electric motors as a strong trend develops toward motors that are lighter in weight and smaller in size. Some of the new motors are deseigned to use copper or aluminum windings, depending upon many factors.

Recent developments in using aluminum as a coating material give promise of adding to the life of steel parts in corrosive and heat applications. The newest method, known as Aldip, provides for the parts to be coated after fabrication. Unlike galvanized steel, steel precoated with aluminum had little protection on edges where shearing had occurred. The aluminum did not flow over cut surfaces. One of the first civilian applications of the method is in coating the steel valves in a major line of 1954 automobiles. More information on Aldip will be found in the section on Coatings and Finishes.

Several new magnesium alloys are about to be generally introduced. These alloys are intended to provide better strengths at higher temperatures. The coming alloys are variations of and improvements on earlier magnesium alloys in which cerium and other rare earths were used as alloying elements. The hope is to provide alloys, eventually, which will retain their strengths up to 600 F.

Investigation still continues into providing coatings to increase the wear and abrasion resistance of magnesium alloys. The HAE coatings developed by Army Ordnance a few years ago, are still considered the best for wear applications. At the same time, other researchers are looking for even better coatings.

There have been predictions of all magnesium aircraft. The thought behind such predictions is that because of magnesium's lightness, it could be used in thicker sections than would be possible in other metals. So sufficient rigidity could be attained without the use of internal stiffeners. Higher metal cost would, in theory, be reduced through the need for fewer component parts and through fewer assembly operations.

Other Metals

During the last several years, there has been an increasing demand for high density alloys for a number of applications. Some of these needs are being met by powder metal parts made of high density alloys based primarily on tungsten. Even though exceedingly expensive (from $15 to $25 per lb) the powder alloys are not too costly in their applications because of the small quantities used. Alloys of this nature, some of which are pressed into unusual shapes by new methods, are used for vibration dampening, balancing rotating objects and to provide a high moment of inertia on other critical parts.

Transistors, made primarily of germanium, were the glamour products of 1953. Nearly every company or laboratory concerned with electronics had products using transistors in various stages of development. Widespread use of transistors is somewhere in the distance, although more proved applications are coming into being regularly. Currently transistors are being used in telephone equipment and in hearing aids. Germanium and pure silicon are both used in transistors but both are very expensive. For that reason, alloys are being developed which have characteristics similar to these two methods. One such alloy announced during 1953 appears to have all of the desired characteristics for transistor use and is much less expensive.

Nonmetallic Materials

The importance of nonmetallic materials is becoming more evident every day. Many are used as engineering materials by themselves; others make possible the extended use of metals and some do both. Of course, the plastics attract the major share of attention because they become familiar to us in both our home and business lives. Other nonmetals serve equally vital functions, but their roles are less widely publicized.

In the case of most nonmetallic materials, at least those that are used most extensively in their natural or modified states, there is little in the way of new compounds from year to year. Most developments in those materials are centered around the utilization of more knowledge of service conditions or in learning better how to shape or fabricate the materials.

Thus, news of new materials is centered among a relatively few materials such as plastics, silicones, ceramic compounds and metal-ceramic combinations.

In plastics, the most important advance is in the use of plastics of many kinds in applications once considered the exclusive realm of metals. For example, plastics piping is now being accepted throughout industry. There are at least seven different plastics materials used for piping. Corrosion resistance and light weight are the two dominant properties of plastics which make them attractive for piping anything from brackish water to corrosive chemicals. The future of plastics piping seems so attractive that at this time there are at least three steel companies entering the field by purchasing companies that were already in that business.

During 1953 we saw the introduction of the first plastics automobile

Here is one use for foamed materials. The section is from an aluminum beer barrel. Between the inner and outer metal skins, an insulating core is foamed into place.

bodies produced by the maker of a major automobile. It is likely that other auto makers will follow suit before long. The same type of material, namely polyester glass reinforced plastics, is now being used to make gasoline tank trucks and other equipment to handle corrosive fluids.

Many high speed aircraft parts are expected to be made of reinforced plastics if and when resins are available that will resist high temperatures. A new high temperature polyester resin is expected soon which will extend the useful range of reinforced plastics. We do have as a recent development, phenolic resins which are capable of use up to about 500 F.

There has been a tremendous increase in the use of foamed nonmetallic materials of many kinds including rubbers, silicones and several kinds of plastics. The foamed materials are used alone and in conjunction with other materials. Foamed rubber, for example, is used in some plumbing applications to replace metal floats. The rubber parts have the desired buoyancy and can be formed into final shape more easily than hollow metal parts. Too, there is no problem of leakage or corrosion.

However, the greatest use of the foamed materials up to this point has been in adding rigidity to formed metal parts such as aircraft wings. The plastics for this application are poured into the open spaces within the parts and then allowed to expand and fill the voids. In addition to providing extra rigidity in the parts, the foamed plastics increase strength without any significant increase in weight. Other uses for foamed nonmetallics are to provide thermal insulation and shock resistance. Two new foamable silicone resins are particularly useful for thermal insulation applications. Foams made from the silicone resins have been subjected to temperatures of 700 F for 20 hr with only slight structural or dimensional change.

Some cast plastics resins, particularly certain phenolics, are being used to an increasing extent to make tooling for drawing and forming sheet metal shapes. At the outset, plastics tooling was considered only for short run jobs, but some users seem to feel that for some shapes,

Added protection for steel and aluminum sheet can be obtained by using a laminated coating of vinyl. The laminated materials resist corrosion and have good strength. Vinyl covered sheets can be stamped or drawn without damaging the surface.

plastics dies can be used for large production runs. After a pattern has been made, the plastics dies can be made inexpensively. Thus, many dies could be used and discarded and still be less expensive than one set of metal dies for the same job. Laminated plastics dies are also used in blanking and forming aluminum, stainless and low carbon steels.

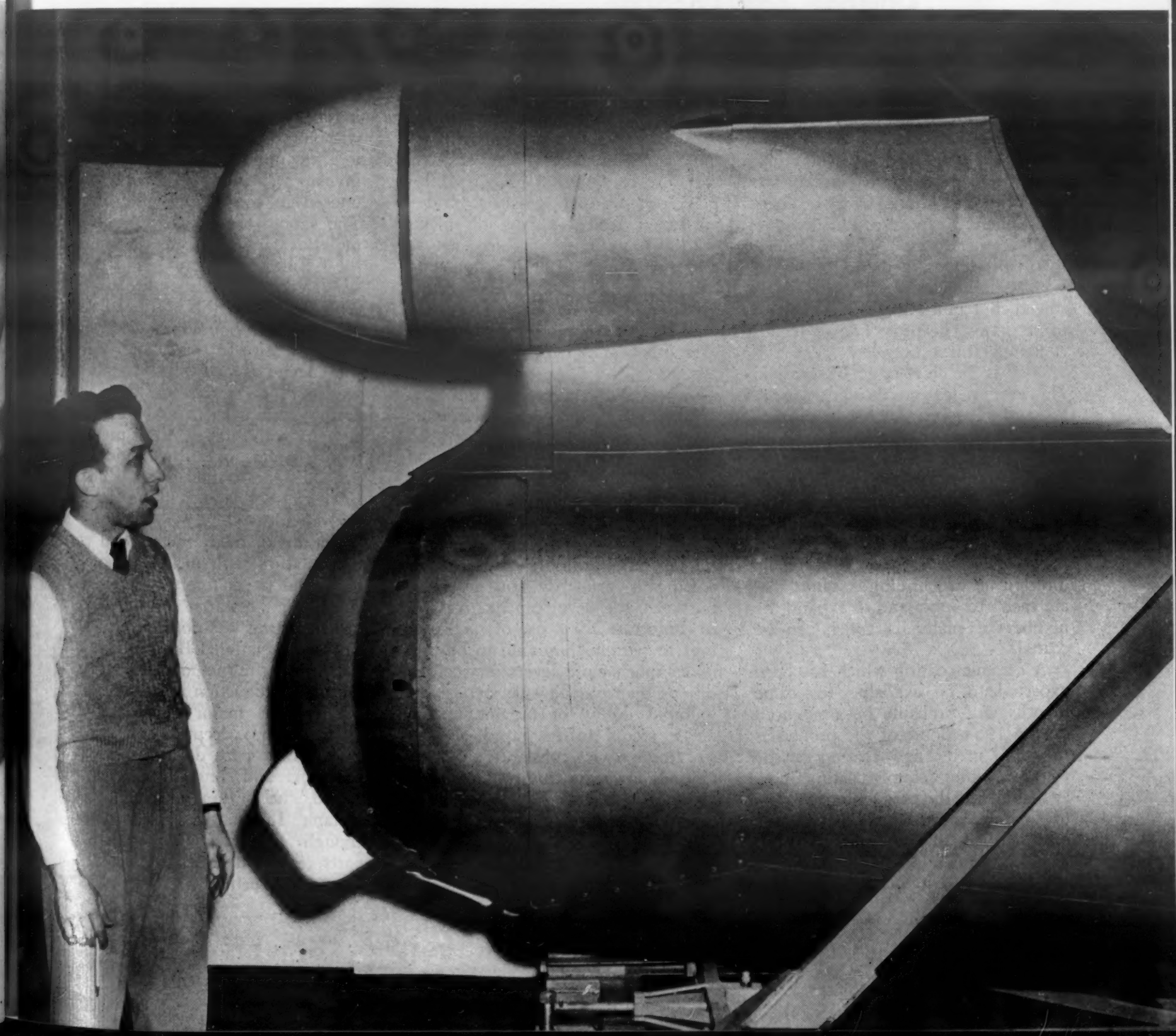
Plastics have become increasingly important in two other areas. Some resins, particularly the epoxys, are now used to a larger extent in adhesive bonding of both metals and plastics. Adhesive bonding is being used in many aircraft applications in this country and abroad. Bonds are strong and durable; in some cases, they are stronger than the base metal. In aircraft, adhesive bonding provides these advantages: simpler and less expensive than riveting, eliminates the need for holes which might become stress raisers in the material being joined, and, permits smooth surfaces to be presented on the outside surfaces of an assembly. The latter point is important in aircraft use as is the fact that the use of adhesive bonding rather than riveting also saves weight.

Another big use of plastics is in the field of shell molding, which is becoming an increasingly important production method. Phenolic resins are used to bind the sands in the casting molds. The resins permit the casting of parts in most castable metals to closer tolerances and with finer finishes than can be achieved by ordinary sand casting.

During 1953 there was announced the availability of a vinyl lamination applied to steel or aluminum sheet to provide additional corrosion resistance to the metal. The metal and plastics are permanently bonded and can be cut and formed without damaging the protective coating. For some applications, the plastics-metal combination is less expensive than plastics alone. The one serious shortcoming of the laminate is that it cannot be welded without damaging the plastics coating in the weld area.

The other area of major activity in the general field of nonmetallic materials is in the development of more and better ceramic-metal combinations. Cermets, as they are called, have been improved considerably and their uses extend far beyond the

Magnesium's lightness is a big advantage in aircraft uses. Here is a B-47 bomber tail cone and turret inclosure of magnesium.



cutting tool applications of the tungsten carbides which were long the chief representatives of this class of materials.

In seeking materials for jet engine turbine buckets and blades, the titanium carbides appear, at this time, to come closest to meeting the needs of such parts. Titanium carbide parts have the strength, high temperature resistance, and other properties needed for blades, but as yet, no way has been found to increase ductibility of the material. In making titanium carbide parts, the carbides are held in place by using binder materials such as nickel, chromium or cobalt. Titanium carbides are now being used in parts requiring high heat and abrasion resistance, but where brittleness is not a serious drawback.

Borides, notably zirconium-boride base compositions, have been found to be exceptionally good for handling molten metals such as aluminum, copper, brass, magnesium and tin. The materials are being used to produce pumps for handling molten metals, as for example the pumps used to force aluminum into die casting dies.

Chromium carbides and certain silicides also came into increased prominence and will probably continue to find applications. The chromium carbides have excellent wear resisting properties and can be used in such parts as plug gages. They resist wear to the extent that accuracy of the gages can be retained for many years.

Silicides, particularly molybdenum silicide is being considered for such diverse applications as heating elements and coatings for molybdenum.

Synthetic mica-ceramics are being considered for many applications now using steatites and other technical ceramics. Shapes of the material are made by hot pressing and can be machined after pressing. Mica-ceramics have excellent dielectric properties and are good for use at temperatures up to 1500 F.

Finishes and Coatings

The seemingly never ending fight to prevent the corrosion of metals is continuing with many new developments aimed at protecting metals under all conditions from ordinary atmospheric exposure to extreme high temperatures. Many problems involving corrosive media or oxidation at high temperatures have been solved, but much work still remains to be done. The protection of metals at temperatures between 1600 and 1800 F is the chief target of research. However, at less spectacular temperatures the problems are to provide longer periods of protection or to reduce costs of finishing.

For high temperature applications, ceramic coatings seem to have the lead as far as potential applications are concerned. Ceramic coatings have proved themselves; now research is directed toward finding coatings that are easier to apply and to expand the number of materials which can be coated.

A ceramic coating which has been expected to be available for some months will probably be announced during 1954. Some of the properties promised in the new coating can be found in other ceramic coatings now available, but the new material seems to combine more advantages in one coating than any other now in use. The coating is said to withstand temperatures up to 3000 F, give satisfactory service in coatings as thin as 0.0005 in. and have extremely low porosity. The material cures at a temperature below 1000 F.

A ceramic coating is also said to be about ready for use on nickel. Nickel has strength required for applications up to 1800 F, but above 1600 F tends to oxidize. So if a satisfactory coating can be found, nickel will be used even more in jet engines and other high temperature apparatus.

Several years ago a ceramic coating was announced for aluminum. At that time, uses were limited, but more recent refinements in the coatings and their processing have widened the horizons for coated aluminum. The first large scale use of ceramic coated plastics is in an aluminum office building. Although the coating is primarily for decorative purposes, the development gives rise to conjecture about use of such coatings to permit aluminum to be used under much more severe service conditions than can now be met.

Rapid drying of organic finishes never seems to be rapid enough, so research is constantly directed towards lowering this problem. One method of achieving faster drying of finishes is by using a sulfur dichloride vapor which is directed against the finished surface for from 2 to 20 sec, which is sufficient to produce an initial set. Hardening is completed without the vapor and is completed in a few minutes. The drying method invokes a chemical process previously unused in connection with finishes. The vapor forms a cross linkage of molecules in the resins and oils of the finishes on which it is used.

Water replaceable enamels are recent arrivals on the industrial scene. Water alone is used to achieve desired viscosity for use. After drying, the enamel is not water-soluble and has good oil resistance. The water feature makes the enamel less expensive than other types, but it meets the requirements of many industries. Presently the enamel is available only in black, but later will be made in several colors.

Plating of many metals and some nonmetallics with nickel is now being done by an electroless method. The basic research on electroless nickel plating was done several years ago at the National Bureau of Standards. Now the method is being used on many production parts. The process has this major advantage over electroplating: deep complicated recesses in a part do not present a problem, and huge parts can be plated, the only requirement being a tank sufficiently large to hold enough chemicals into which the parts can be dipped. Plating by the electroless method is not intended

as a decorative method, although smooth surfaces under the plated coating will produce a good plated surface as far as eye appeal is concerned.

The plating of iron metal powder parts has long been the goal of researchers. Several processes have been announced during the past few years. Porosity of the parts usually caused trouble in the plated parts due to chemicals becoming trapped under the plating. Difficulties of this nature are said to be eliminated in a new 8-step preplating process recently perfected. Among the steps in the process is impregnation under high vacuum. Coatings of copper, nickel, chromium, zinc or cadmium can be plated onto the iron surfaces by normal electroplating processes without absorption of the plating chemicals and subsequent migration.

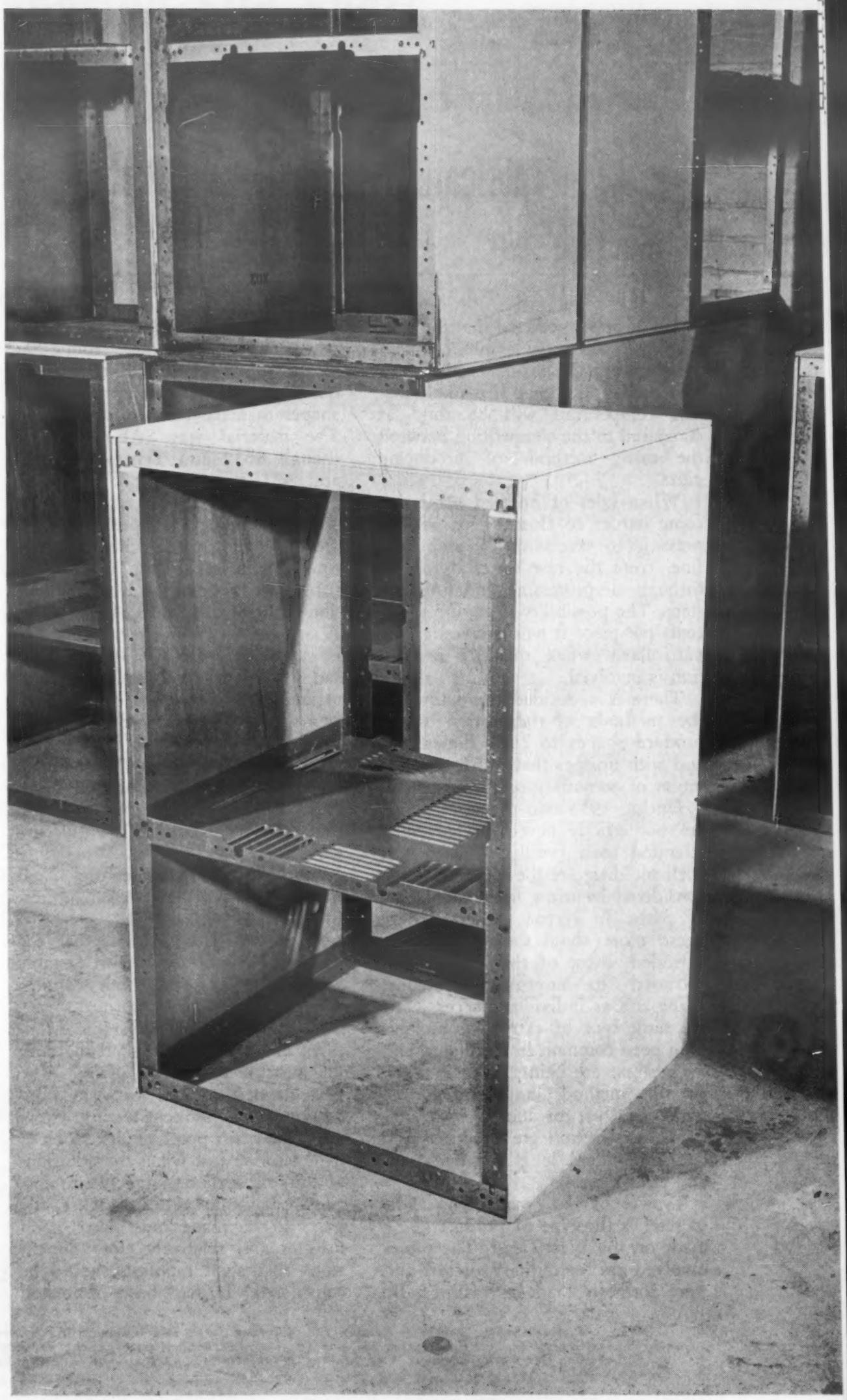
Should the supply of nickel be limited, and even if it is not, there are likely to be more uses of the tin alloys for plating other metals. Certain tin coatings which were first announced during periods of tin scarcity are now being investigated more thoroughly.

Reference was made earlier to a new process for coating steels with aluminum. As was mentioned, the coating method differs from former aluminum coating methods in that the coating is applied after parts have been fabricated, rather than as a coating on the sheet or strip. When the latter type of material was cut, edges became exposed and unprotected.

Parts coated by the new process resist corrosive gases and atmospheres up to 900 F with the coating in the as-coated condition. When resistance to higher temperatures is required, the part is given a diffusion heat treatment which extends the temperature range considerably.

As an example of how and where the dip coated parts are used we cite a diesel engine exhaust manifold which was formerly made of Type 321 stainless steel. The use of aluminum coated plain steel for the part resulted in a saving of 2.5 lb of nickel and 4.5 lb of chromium.

Electroplating which was once confined most generally to stainless steels is now being used on a number of metals. In some cases polishing is done for decorative purposes, but latest applications are to attain smoothness to improve serviceability on such objects as tips of fountain pen points and electrical contacts.



Competition among materials is increasing, and some older materials are regaining ground lost to newcomers. An example of a reverse shift in this in which metal and wood combine to recapature an application lost to plastics. Here wood veneer is glued over a steel framework to produce an attractive, lightweight, and inexpensive television cabinet.

Fabricated Materials and Parts

It has been predicted that the next year will see considerable competition between various materials for all kinds of applications. It is likely that this competition will be mild as compared to the competition between the many methods of producing parts.

When sales of finished goods become harder to close, there will be pressure to save costs all along the line, from the raw materials on up through all processing and finishing steps. The possibility of saving a few cents per piece is worth investigating particularly when quantity production is involved.

There is a decided trend towards the methods of fabrication which produce shapes to close dimensions and with finishes that call for a minimum of secondary operations.

During 1953 two processes which are not strictly new attracted more attention than ever. Extruding and shell molding are the methods being considered by many more purchasers of parts. In recent years we have heard more about steel parts being extruded. Most of these have been extruded to approximately final shape and as individual pieces. Now the same type of extrusions as have long been common in aluminum and magnesium are being made in steel. By this method, long extrusions—perhaps 30 ft or more—with uniform cross-section are produced and then individual lengths are cut off and put to use.

Typical of the work being done in steel is the type of product being made on the West Coast. The pieces involved are for military aircraft and were formerly made as castings. By changing from castings to extrusions, cost per piece was redued from $29.-40 to $8.90. Only drilling was required on the cut-to-length extruded shapes to make them ready for use. The material was SAE 8630, although 8632 and Types 434, 410, and 431 stainless steels have also been extruded.

Extrusions in steel up to 32 ft long are now being made with some section thicknesses being as little as 0.100 in. to 0.907 in. Extruding is done at temperatures as high as 2300 F and the user reports excellent finishes and tolerances. With die costs ranging from $200 to $500 it is claimed that extrusions can be used at a saving even when as little as 50 ft of a special alloy is to be extruded.

Shell molding is now growing to the extent that hundreds of foundries are now producing parts by that method or seriously considering adoption of the process. When first introduced into this country, shell molding was thought to be applicable only to the light metals, but by now it has been learned that the process is useable with most castable alloys including beryllium coppers and high alloy steels.

There is still considerable argument as to just where shell molding fits into the production picture. The best defined area is between sand casting and investment casting. However, the main point of discussion is to determine just when the additional costs of shell molding can be justified. It is definite that when the parts to be made must have good finishes and relatively close dimensions that shell molding should be considered. It has been estimated that more than 50 million pounds of resin will be used for shell molding by 1957. That figure compares with about 5 to 10 million lb in 1953.

There also seems to be an increasing use of drawn and stamped parts even when relatively small quantities are involved. At one time—not very long ago—drawing was considered to be a production method that could only be considered when large quantities of parts were involved. Now stamping and drawing are used when only a relatively few parts are required. The change comes about through the development of die materials which can be formed at relatively low cost. Die materials include zinc-base alloys, antimonial lead, bismuth-base alloys, hard wood, densified wood, reconstituted wood, cast phenolic plastics and laminated plastics.

Another reason for the trend to short runs is the development of equipment and methods which use only a half die, plus a rubber blanket or a hydraulically backed up die cushion which forces the metal around the half die that is used. In addition to permitting runs of smaller quantity, the newer methods allow deeper draws, form thicker sheet and plate and avoid wrinkles and tears which sometimes result from normal deep drawing dies.

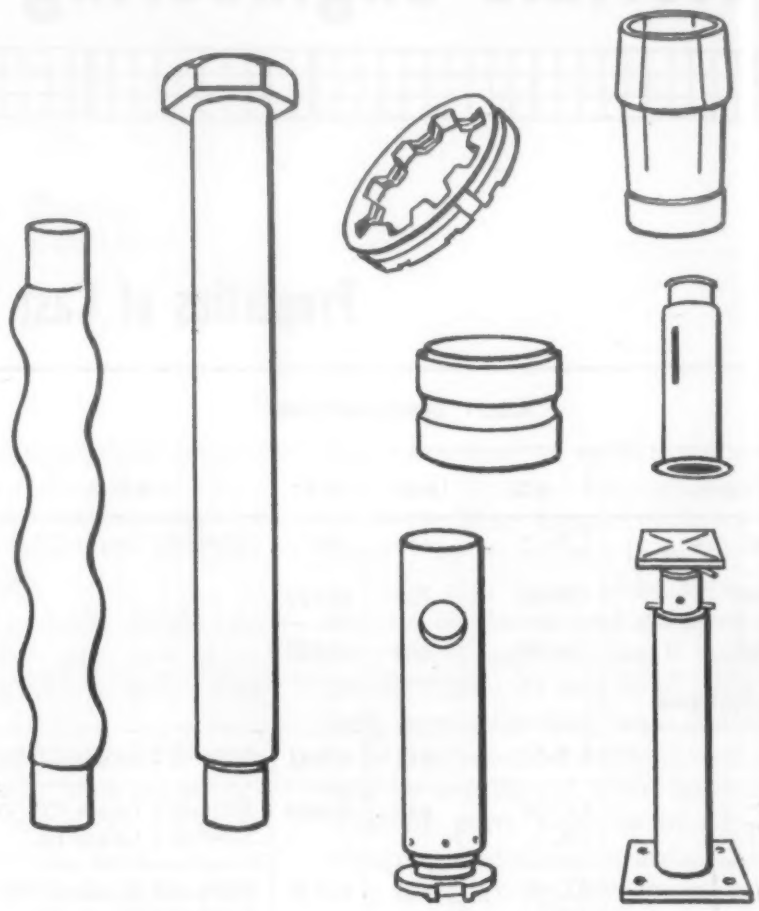
Finally, there is a report from the West Coast that one of the aircraft companies has perfected a method for producing square spinnings. Should this method prove practicable on a variety of metals it could serve as another method to consider when a method must be found to produce a limited quantity of parts.

Picture Credits: Brooks & Perkins, Inc., Chrysler Corp., Dow Chemical Co., Durez Plastics & Chemicals, Inc., General Electric Co., Harvey Machine Co., Inc., Lockheed Aircraft Corp., Minnesota Mining and Manufacturing Co., Monsanto Chemical Co., Mullins Manufacturing Corp., Solar Aircraft Co., United States Rubber Co.

Properties of Cast Stainless Steels

ALLOY DESIGNATIONS					NOMINAL ANALYSES						
Type	ACI	AISI*	SAE*	ASTM	C	Cr	Ni	Si	Mo	Special	
12CrLC	CA-15	410	60410	A296-49T Grade CA-15	.10	12.5	.5	.75			
12CrMc	CA-40	420	60420		.20	12.5	<.5	.75			
12CrHC	CA-40	420	60420		.30	12.5	<.5	.75			
12Cr-Tool Steel					1.5	12.5		.5	1	Co<1	V 1
18Cr	CB-30	442	60442	A296-49T Grade CB-30	.25	18	<.5	.75			
28Cr	CC-50 HC	446	60446	A296-49T Grade CC-50 A297-49T Grade HC	.30	28	<1	.75			
28-3	CC-50 HC	446	60446	A296-49T Grade CC-50 A297-49T Grade HC	.30	28	3	.75			
28-3Mo	CD-10M	329			<.10	28	3	.75	1.5		
28-3HC					1.00	28.0	3.0	.75			
18-8S	CF-8	304	60304	A296-49T Grade CF-8	<.08	19	9	1.25			
18-8SCb	CF-8C	347	60347	A296-49T Grade CF-8C	<.08	19	9	1.25		Cb8xC (1.0 Max)	
18-8SMo	CF-8M	316	60316	A296-49T Grade CF-8M	<.08	19	10	1.25	2.5		
18-8FM	CF-16F	303	60303	A296-49T Grade CF-16F	<.16	19	9	1.25	<1.5	Se .25	
18-8	CF-20	302	60302	A296-49T Grade CF-20	<.20	19	9	1.25			
20-10	CG-12	307–308	60307	A296-49T Grade CG-12	<.12	20.5	10.5	1.25			
8-20	CM-25	325			.25	9	20	1.5			
18-8MoCuBe					<.07	19	10	3	3	Cu 2	Be .15
20-25Mo	CN-7M				<.10	20	25	1	1.5		
20-29MoCu	CN-7MCu				<.07	20	29	1	3.5	Cu 4	
25-12S	CH-10			A296-49T Grade CH-10	<.10	25	12	1			
25-12SCb	CH-10C				<.10	25	12	1		Cb8xC (1.0 Max)	
25-12SMo	CH-10M				<.10	25	12	1	2.5		
25-12	HH	309	70309	A297-49T Grade HH B190-50 Type #1 & #2	.30	25	12	1.5	<.5		
23-12W					.20	23	12	1.5	<.5	W 3	
29-9	HE	312	70312	A297-49T Grade HE A296-49T Grade CE-30	.30	29	9	1.5	<.5		
25-20	HK	310	70310	A297-49T Grade HK	.30	25	20	1.5	<.5		
15-35	HT HU	330	70330	A297-49TGradeHTorHU B207-50	.40	15	35	2	<.5		
15-65	HW	335	70335	A297-49TGradeHWorHX	.40	15	65	2	<.5		

** The AISI and SAE type Nos. cover equivalent chemical analyses for wrought products.*



Take a closer look at the

ADAPTABILITY

of B&W mechanical tubing *You'll like it*

It would be difficult indeed to name any round hollow part or structural assembly that can't be *machined* or *formed* out of B&W Mechanical Tubing – at worthwhile economies in time, costs and materials. It will pay you, as it has so many others, to look into its great versatility and the opportunities it affords for cutting production expense and improving product quality.

B&W Mechanical Tubing—both seamless and welded – is available in stainless, alloy and carbon steels, in tempers, grades, finishes and sizes to suit any needs.

Call on Mr. Tubes – your nearby B&W Tube Representative – if you want help in determining the mechanical tubing best suited to your needs. Get the benefit of his long, close association with mechanical applications of all kinds to help you cut costs while keeping production high.

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio—Welded Carbon Steel Tubing

TA-1747(C

For more information, turn to Reader Service Card, Circle No. 480

Cast Stainless Steels (Continued)

Type	TYPICAL MECHANICAL PROPERTIES AT ROOM TEMP.						HEAT; TREATMENT
	T. S. (PSI)	Y. P. (PSI)	% Elong 2. in.	Red Area %	Brinell	Charpy	
12CrLC	197,000 116,000	139,000 96,000	16 23	42 60	372 230	13 25	H&SR600F N&D1200F
12CrMc	222,000 125,000	160,000 100,000	12 20	34 55	412 237	3 14	H&SR600F N&D1200F
12CrHC	222,000 141,000	168,000 114,000	1 14	1 17	474 267	1 5	H&SR600F N&D1200F
12Cr-Tool Steel					223 653		Annealed Hardened
18Cr	75,000	50,000	10	12	170	2	A1450F—AC
28Cr	75,000	50,000	2	2	196	1	As Cast
28-3	100,000	61,000	13	12 17	207	2	A1650F—AC
28-3Mo	85,000	56,000	5	6	228	2	A1650F—AC
28-3HC					300		As Cast
18-8S	78,000	38,000	55	60	140	75	2000F—WQ
18-8SCb	85,000	44,000	45	50	150	30	2000F—WQ
18-8SMo	88,000	45,000	50	55	160	70	2000F—WQ
18-8FM	80,000	42,000	45	50	155	75	2000F—WQ
18-8	83,000	42,000	55	60	155	75	2000F—WQ
20-10	80,000	40,000	55	60	155	75	2000F—WQ
8-20	79,000	47,000	23	24	150	80	As Cast
18-8MoCuBe	152,000	122,000	3	2	363		2000F—WQ and hardened at 925 F
20-25Mo	70,000	35,000	20	20	140		2000F—WQ
20-29MoCu	75,000	40,000	45	50	150	15	2000F—WQ
25-12S	82,000	44,000	40	40	165	70	2000F—WQ
25-12SCb	90,000	55,000	25	25	175		2000F—WQ
25-12SMo	95,000	60,000	20	20	185		2000F—WQ
25-12	90,000	45,000	26	27	170	15	As Cast
23-12W	93,000	52,000	32	30	185		1950F—AC
29-9	85,000	45,000	10	13	204	10	As Cast
25-20	75,000	47,000	16	17	175	12	As Cast
15-35	65,000	40,000	8	9	168	4	As Cast
15-65	72,000	40,000	8	10	185	5	As Cast

A—Annealed. AC—Air cooled. WQ—Water quenched.
H & SR—Hardened and stress relieved. N & D—Normalised and drawn.

When you're really "in the soup"...

In weather like this, flying is no fun.

Visibility is *zero*. Your storm-lashed plane rocks and shakes as it beats into the blackness.

You rely on the pilot. And he relies on instruments — delicate mechanisms, every one of them — to bring you in to a safe landing.

How high? How low? How fast? How slow? The answers are all on the dials. The answers are accurate, too, because modern instruments are well protected from damaging vibration by devices called "shock mounts."

Shock mounts fashioned of conventional cushioning materials are satisfactory up to a point, but they were never perfect in every way.

Under constant vibration, some have a tendency to pack down and lose resiliency. Others are at the mercy of heat and cold . . . pick up dust, oil and moisture . . . or are attacked by bacteria and fungi. Obviously, something better had to be found.

A kitchen pot cleaner of knit Monel® mesh finally put searchers on the right track. The Metal Textile Corporation knitted it with different types and thicknesses of Inco Nickel Alloy wire . . . stretched it . . . compressed it . . . subjected it to test after test.

Knit metal mesh had none of the faults of its forerunners. Even when compressed, it retained a high degree of resiliency, for the knitted loops acted like thousands of tiny springs. Here at last was the answer!

Today, knit metal mesh that traces its origin to a pot cleaner, serves on many jobs once handled not nearly so well. In addition to shock mounts, knit metal mesh is found in air filters on carburetors, and as padding on pressing machines. It's used for straining and filtering fluids and gases — and RF Shielding of electronic components.

Just let your own imagination run. With Monel wire you have a strong, non-rusting mesh structure that resists shock and impact, heat and cold, wear and corrosion. With other Inco Nickel Alloys, you can add extra strength, if that is needed, or electrical or thermal conductivity, or other desired properties.

Have you a metal problem that's really got you "in the soup"? Then bring it to us. We're always glad to help you find a solution. All you need do is write: The International Nickel Company, Inc., 67 Wall St., New York 5, N. Y.

Inco Nickel Alloys

Monel® • "R"® Monel • "K"® Monel "KR"® Monel • "S"® Monel • Inconel® Inconel "X"® • Inconel "W"® Incoloy® • Nimonic® Alloys • Nickel Low Carbon Nickel • Duranickel®

Cast Stainless Steels (Continued)

Type	APPLICATIONS AND REMARKS
12CrLC	A mildly corrosion resistant alloy capable of being heat treated for high strength and hardness. Has a low coefficient of expansion. Used for valves and valve trim, pump parts, etc., especially in power plant and oil refinery equipment. Weldability is fair and machinability good after annealing.
12CrMc	Higher carbon content gives higher hardness after heat treating than CA15 with little sacrifice in corrosion resistance. Has same uses as CA15. Weldability is fair and machinability good after annealing.
12CrHC	Slightly less corrosion resistant than CA15. Capable of being heat treated to high hardness for abrasion and erosion resistance. Weldability is fair and machinability good after annealing.
12Cr-Tool Steel	A very highly abrasion resistant alloy for use under mildly corrosive conditions. Used in grinding rings for disposal units, abrasion plates, jet engine afterburners and all abrasive services not subject to great shock or severe corrosive conditions. Not weldable.
18Cr	Much better corrosion resistance than CA15. Cannot be hardened by heat treatment. Used for food processing, nitric acid and rayon manufacture, rabble blades in ore roasting furnaces, etc. Weldability is fair and machinability fairly good.
28Cr	Mainly a heat-resistant alloy, good in hot high sulfur bearing gases. Used for pump parts in erosive mine waters, nitric acid manufacture and in coarse high temperature parts. Brittle when slowly cooled to room temperature. Weldability poor to fair and machinability fair to good.
28-3	The small amount of nickel added to this alloy gives it much greater ductility than the CC50HC type; in general the uses are the same. Weldability is fair and machinability good.
28-3Mo	The addition of molybdenum to the 28-3 alloy provides for better corrosion resistance. Good in pump parts used for highly acid mine waters. Alloy is sometimes used to handle hot sulfite liquor in paper mills. Weldability is fair and machinability good.
28-3HC	A heat and corrosion resisting alloy with high abrasion and erosion properties. Used in As Cast conditions for roasting furnace blades, pump parts for handling abrasive and corrosive materials, protection plates, chemical mixing blades, etc. Weldability is poor and machinability is poor to fair.
18-8S	General purpose corrosion resistant alloy for applications in chemical, pharmaceutical, textile, and food processing industries, and in oil refineries. Carbon is held low for maximum corrosion resistance. Weldability and machinability are fairly good.
18-8SCb	Columbium is added to the CF8 analysis to prevent detrimental chromium carbide precipitation and intergranular corrosion, obviating heat treatment after welding operations. Same uses as CF8. Weldability and machinability are fairly good.
18-8SMo	The molybdenum addition to the CF8 analysis gives added corrosion resistance in sulfite liquors and many chemicals, reduces pitting corrosion, and helps prevent corrosion of the intergranular type. Weldability and machinability are fairly good.
18-8FM	Selenium addition to the CF analysis gives great ease of machinability and freedom from galling. Uses are the same as for CF20 except for heat applications. Weldability is poor to fair and machinability excellent.
18-8	Alloy for less exacting corrosion applications than CF8. Used largely for dairy processing parts and intermediate temperature heat applications. Weldability and machinability are fairly good.
20-10	Has slightly higher corrosion and temperature resistance than the CF20 type. Applications are similar. Weldability and machinability are fairly good.
8-20	An alloy resistant to medium temperatures and conditions of corrosion, used for electrical resistance grids, thermocouple wells, plugs in return headers in oil refineries, etc. Weldability is good and machinability fair.
18-8MoCuBe	A non-galling highly corrosion and erosion resistant alloy of high strength and hardness. Machinable in the quench-annealed condition before low temperature hardening. Used for valve discs, pump impellers, gears and other wearing parts. Only repair welding recommended.
20-25Mo	An alloy possessing better corrosion resistance to mild sulfuric acid concentrations than CF8M. Useful in the paper industry and in other similar applications. Weldability is good and machinability fair.
20-29MoCu	An alloy developed primarily for use in hot sulfuric acid of most concentrations. Has superior resistance to CF8M in all media. Weldability is fair to good and machinability good.
25-12S	An alloy having higher chromium and nickel contents than CF8 thus giving better corrosion resistance. Especially good in nitric acid, otherwise has same uses as CF8. Weldability is fairly good and machinability fair.
25-12SCb	Best chromium-nickel alloy for resistance to intergranular corrosion. Same uses as CF8C with better corrosion resistance. Weldability is fair and machinability fairly good.
25-12SMo	Has improved corrosion resistance over CF8M and similar uses. Weldability is fair and machinability fairly good.
25-12	An alloy for economical high temperature structural applications. Subject to embrittlement unless composition is properly balanced. Used for tube supports, dampers, and general furnace parts. Weldability is fairly good and machinability fair.
23-12W	A high strength and heat resistant alloy with a low creep rate. Used for heat applications where stress and hot gas corrosion rate are very high. Cast centrifugally in metal molds to form jet enginerings. Weldability and machinability fairly good.
29-9	For heat resistant use in fairly high sulfur bearing atmospheres and for corrosion resisting applications in hot sulfite liquor. Weldability and machinability are fair to good.
25-20	Best all around alloy for high temperature service except in presence of large amounts of sulphur gases. Higher nickel content makes it more stable than HH in similar applications. Weldability and machinability are fairly good.
15-35	Most widely used alloy for carburization and cyclic heating services. May be had with a columbium addition for added resistance to thermal fatigue cracking. Used for retorts, lead and cyaniding pots, heat treating trays and fixtures, etc. Weldability is fair and machinability good.
15-65	Premium alloy for carburizing and cyclic heating services in which it excells. Will not crack or warp. Must not be used in high sulfur bearing atmospheres. Used for retorts, lead and cyaniding posts, heat treating trays and fixtures, autoclaves, etc. Weldability and machinability are good.

Prepared by N. S. Mott, Chief Chemist and Metallurgist, Cooper Alloy Foundry Co.

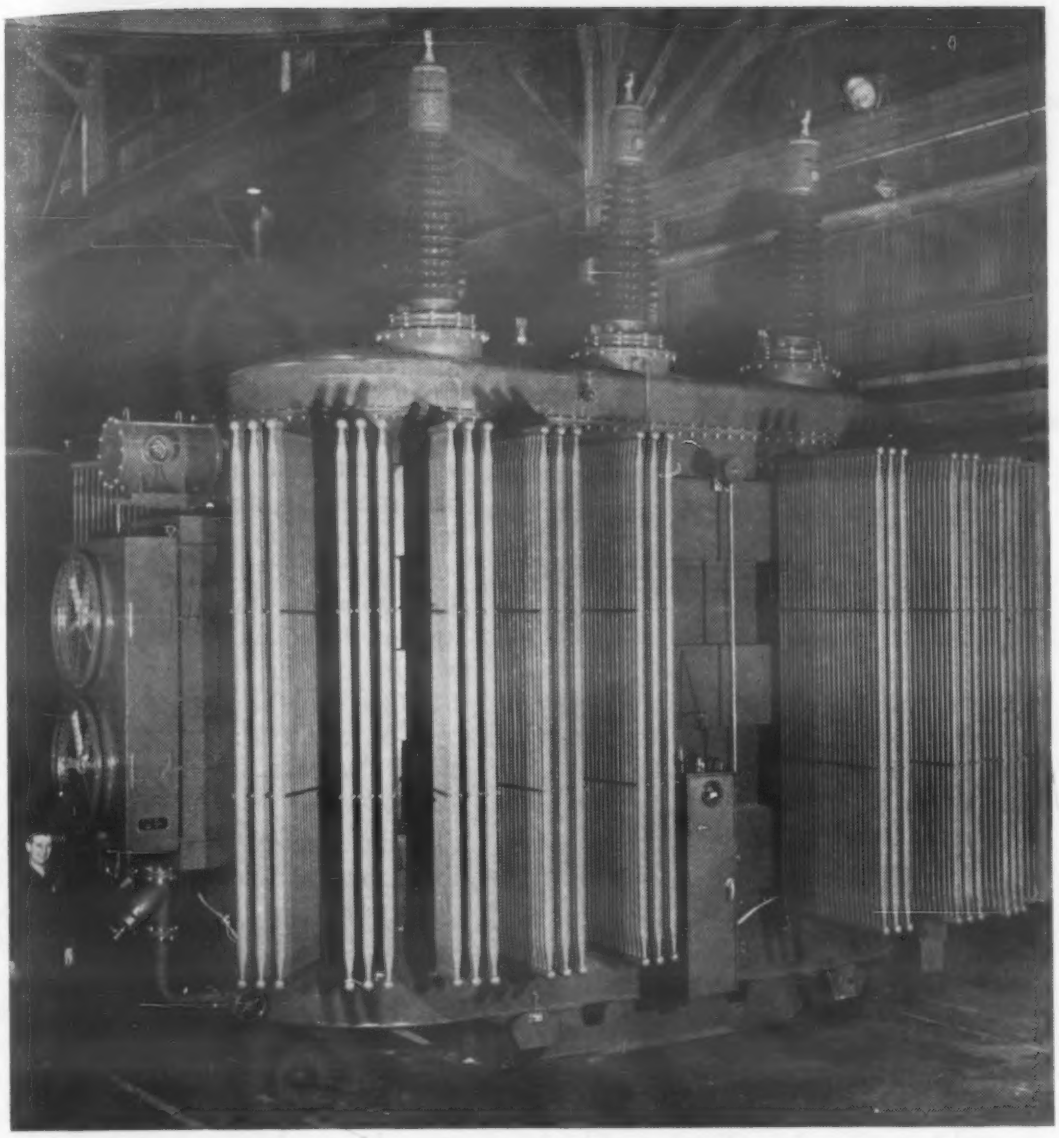
Weight Reduced by Using . . .

Transformer tanks are being fabricated of high strength Cor-Ten steel.

High Strength Low Alloy Steels in Transformer Equipment

● IN RECENT YEARS the increase in physical size and weight of power transformers has presented problems in manufacture and handling that call for reconsideration of certain concepts of design. Since transformers that weigh over 200 tons when filled with oil are now being manufactured, the shipping problem becomes acute. One of the most obvious ways in which weight reduction can be accomplished is by selecting materials with higher physical properties which will allow a decrease in the mass weight of the component. An example of this in the manufacturing of transformers is the progress in weight reduction that has been made by the use of grain oriented, cold rolled, silicon steel cores.

Another method used with steadily increasing application in transformer manufacture is the substitution of high strength steel, low alloy plate for plain carbon steel for shells, bottoms, covers, and shell-reinforcing bands. The steel, known as Cor-Ten, is a low carbon, chromium-nickel-silicon-copper-phosphorus type steel having a yield point at least 1½ times that of plain carbon steel and 4 to 6 times the atmospheric corrosion resistance of plain steel.



The use of thinner sections of Cor-Ten steel reduced the weight of this finished 58,000 Kva power transformer.

Thinner sections of higher strength steels in transformer equipment reduce weight and ease shipping and handling problems. Increased corrosion resistance also offers advantages to the customer.

by M. M. ARONSON, Pennsylvania Transformer Co.

Stress Considerations

In selecting this grade of steel for this application, structural strength is one of the major factors to be considered from the design standpoint. The substitution of thinner sections of higher strength steel is justified when the imposed loads cause tensile and/or bending stresses, but where these stresses do not produce objectionable deflections. Excessive deflections cannot be tolerated as they are not only unsightly, but may impose undue strains on the various accessories on the finished transformer.

The capacity of the material to resist tensile and bending stresses depends upon its physical dimensions and properties. However, where buckling is induced by compression and the tensile strength cannot be utilized, the load capacity of the material is wholly dependent upon physcial dimensions of the steel and its modulus of elasticity. Since all carbon and low alloy steels, have the same modulus of elasticity or elastic stiffness, it is obvious that thinner sections of this higher strength steel subjected to the same loads as plain carbon steel will experience higher stresses with correspondingly greater

(Continued on page 136)

continued from page 135

deflections. Should buckling tendencies predominate, critical stresses may occur at stress values considerably below the yield point. The deflections caused by the buckling will increase eccentricities, thereby increasing stress, all of which contribute to premature failures.

In the use of Cor-Ten, empirical formulas developed as a result of tests made by the Pennsylvania Transformer Co. indicate that by judicious selection and strategic location of the necessary reinforcing bands (also fabricated from Cor-Ten), adverse elastic effects can be minimized to allow full utilization of the material's strength.

Corrosion Resistance

The ability of exposed surfaces to resist corrosion is an especially desirable feature for transformers located in corrosion-accelerating industrial and marine atmospheres. Although transformer surfaces are protected by a liberal application of high quality paint, prolonged exposure requires a periodic reapplication of this surface protection. The service removal and restoration period necessary to accomplish this maintenance service is often inconvenient, costly, and time-consuming. The relatively high resistance of Cor-Ten to atmospheric corrosion permits a greater interval between these maintenance periods. Thus, maintenance costs can be reduced without sacrificing the service life or structural strength of the transformer.

Cost Considerations

Cor-Ten, being a premium grade steel, costs approximately 50% more than plain carbon grades. However, this fact alone should not be viewed as prohibitive since, depending on the individual transformer, the reduction in weight thus effected will, many times, offset the higher price of the material. A cost-weight analysis of a group of Pennsylvania "Standard Parts" power transformers rated 600 to 7500 kva indicated an average increase of $36 per unit with the use of Cor-Ten. However, this amount is considered well-spent in view of the fact that the customer receives a lighter weight transformer, and one that has greater resistance to corrosion.

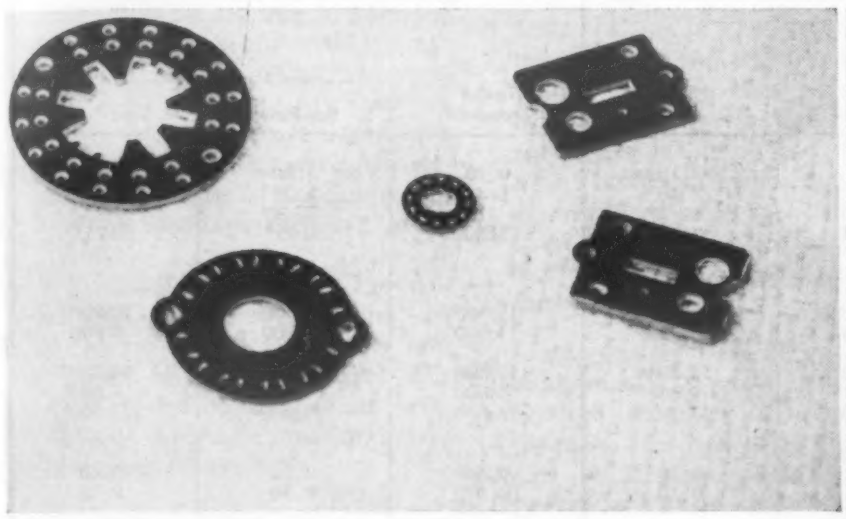
More decisive data was obtained by studying the cost-weight ratio of larger transformers. These were of a three phase type designed for maximum pressure and vacuum requirements, with elliptical-shaped tank shells reinforced with peripheral fabricated channels, flat bottom plates with external reinforcing channel base members, and domed covers. By redesigning one such unit with a self-cooled rating of 60,000 kva and an insulation level of 138 kva, the use of Cor-Ten plate reduced the weight of the finished product by 14,000 lb. The addition material cost of $100 was more than offset by a decrease in shipping cost of $290.

Reduced costs can also be brought about by changes in reinforcing design permitted by the use of this higher strength material. In the design of either plain carbon steel or Cor-Ten tanks, the problem of arranging reinforcing bands to avoid the numerous accessories attached to the tank wall is frequently a complex one. In a plain carbon tank, however, a maximum number of bands is required due to the limitation of allowable stresses. The substitution of high strength Cor-Ten on a unit rated 12,000 kva 92 kv permitted the elimination of one peripheral reinforcing channel resulting in a shipping weight reduction of 3600 lb. In this case, an increase in material cost of $148 was balanced by a savings in shipping cost of $139 and a substantial reduction of manufacturing cost.

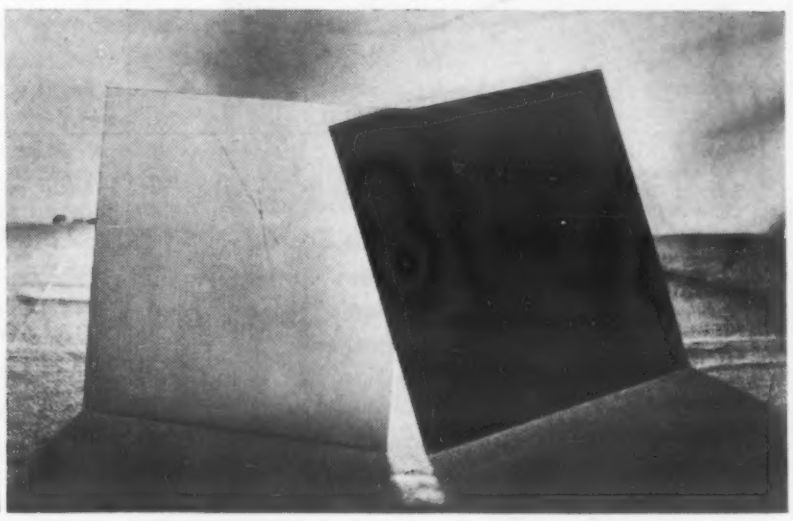
During heavy production periods, the introduction of a new material should not require radically new techniques nor should it seriously affect the economy of established shop fabrication procedures. Factory equipment operators at Pennsylvania Transformer have indicated that high-strength steel requires more power than plain carbon steel for such operations as cold forming, shearing, punching, and drilling but that this increase in power is well within the capacity of the company's equipment. Gas cutting and welding, two more major fabricating procedures, are readily performed with this steel by merely exercising the same precautions in preparation and procedure as with plain carbon steel. These results indicate that there is very little difference in fabrication behavior between the high strength and plain carbon steels.

New Materials, Parts, and Finishes

. . . and Related Equipment



Punched parts fabricated from phenolic laminate show intricate shapes possible with this new paper based material.



Sheet of XXXP-300 on the left shows the translucency of this grade, while a sheet of XP-400 on the right is opaque.

New Paper Based Phenolic Laminates Offer

• High Electrical Properties
• Good Punching Characteristics

Two new paper based phenolic laminates have been developed by *Taylor Fibre Co.*, Norristown, Pa., particularly for applications where high physical and electrical properties are required, yet where intricate punching and staking operations are necessary in fabrication.

Taylor XXXP-300 is said to be the start of a new family of paper base, phenol laminates for use in electronic components requiring the ultimate in insulation resistance (300,000 megs—cond.:C96/35/90). According to the company it hot-punches evenly at about 270 F, has a high dimensional stability, low water absorption and is flame retarding.

Taylor XP-400 is said to meet the need for a true cold-punching laminate. The company claims that the material can easily be punched and staked at room temperature, allowing obvious production advantages. It is also said to have good impact strength, low water absorption, and a high dielectric strength.

These two materials were developed from the conventional line of paper based resinous materials of the Phenol Formaldehyde type which combine high dielectric and mechanical strength in waterproof insulation. They have a good resistance to heat or cold, are resistant to oil and most chemicals and are suited to the machining of accurate parts.

In the manufacture of these laminates, the paper base is first drawn through an impregnating bath of synthetic phenolic resin dissolved in a solvent. The material then moves to drying ovens where the solvent is driven off. Finally the resin-coated base material is pressed in multiple layers in a heated press under high pressure. This causes the resin to flow enough to make an homogeneous material before setting to infusibility and insolubility, which characterize the finished product. In the manufacture of the two new materials, the process used is essentially the same. However, according to the company, the improved properties are attributable to an improved phenolic resin developed in their laboratories.

Both materials are supplied in sheets only, 49 by 49 in. and up to 1/8 in. in thickness. The sheets are available in dull finish or, after Jan. 1, 1954, in #4 plate finish, in natural color. The XXXP-300 can be punched at about 270 F in thick-

New Materials, Parts, and Finishes continued

nesses up to 1/16 in., while for thicker pieces higher temperatures will be more satisfactory. The XP-400 can be cold punched and sheared up to 3/32-in. thicknesses.

The following table of properties compares the Taylor standards for the materials with those established by the National Electrical Manufacturers' Association.

Properties of New Paper Base Laminates

	XXXP-300 1/16-in. material unless otherwise noted		XP-400 3/32-in. material unless otherwise noted		
				NEMA	
	Taylor Standard	Nema XXXP	Taylor Standard	Hot Punch	Cold Punch
Physical Properties					
Water Absorption E-1/105 and D-24/23	0.50	1.00% max	0.70	2.80	4.00
Specific Gravity	1.35	1.30*	1.31	1.33*	1.34*
Cubic in./lb	20.4	21.2*	21	20.8*	20.6*
Rockwell Hardness	M-105	M-105*	M80	M95*	M75*
Mechanical Properties					
Flexural Strength, Flatwise, Psi					
Lengthwise	20,000	12,000	13,000	13,000	10,000
Crosswise	17,000	10,500	11,000	11,000	8,000
Tensile Strength, Psi					
Lengthwise	13,000	12,400*	12,000	12,000*	10,000*
Crosswise	11,400	9,500*	9,000	9,000*	8,000*
Compressive Strength, Flatwise, Psi	40,000	25,000*	25,000	25,000*	22,000*
Izod Impact Strength, Edgewise, ft lb/in.					
Lengthwise	0.44	0.35	0.66	0.55	0.60
Crosswise	0.47	0.30	0.62	0.50	0.55
Electrical Properties					
Dielectric Strength, Parallel to Laminations, Kv, Step by Step Test:					
Cond. A	65	60	62.5	40.0	**
Cond. D/48/50	59	15	16.0		
Perpendicular to Laminations, Vpm					
Short time test	800	650*	698		
Step by step test	670	450*	605		
Flame Retardance, Sec (Underwriter Test Method)					
FW	8		2		
20 deg angle	40		45		
The following properties are given for XXX-P-300 alone, since no standards for electrical properties of XP-400 are contemplated due to the fact that it is not primarily an electrical grade.					
Power Factor					
1MC { Cond. A	0.027	0.030			
1MC { Cond. D-24/23	0.029	0.035			
60 cycle { Cond. A	3.0%				
60 cycle { Cond. D-24/23	5.0%				
Dielectric Constant					
1MC { Cond. A	3.72	4.60			
1MC { Cond. D-24/23	4.75	4.80			
60 cycle { Cond. A	4.18				
60 cycle { Cond. D-24/23	5.15				
Loss Factor	0.10				
Insulation Resistance					
Cond. C96/35/90 (Megs)	300,000	20,000*			

**NEMA Authorized Engineering Information only.*
Tests conducted following test methods of the American Society for Testing Materials.

Flux Aids Welding of Aluminum Bronze Sheet

A new powdered flux has been developed for use primarily in the welding of Ampco 8 and other types of aluminum bronze sheet and plate by *Ampco Metal, Inc.*, 1745 S. 38th St., Milwaukee 46. According to the company it may be used with inert-gas processes and bare Ampco-Trode filler rods in all grades. It is also said to be successful in joining other copper alloys, such as the silicon bronzes, tin bronzes and brasses.

The manufacturer's claims for the flux include the removal of oxides from the weld metal; reduction of surface tension, allowing the deposit to flow into the side walls more uniformly; and full penetration in straight butt joints at lower welding currents and preheats.

The flux should be mixed with an alcohol and painted on all surfaces of the joint to be welded. It may also be applied to the bare filler rod, though generally this is not required. Alcohol is recommended as a vehicle because it air dries rapidly.

Ampco-Weld Flux is available in one lb jars.

Automatic Controller Aids Materials Testing Programs

A complete line of Program Controllers for production and quality control testing, as well as for use in the field of research and development, has been developed by the *Tinius Olsen Testing Machine Co.*, Easton Rd., Willow Grove, Pa. These controllers are said to offer the following advantages in materials testing: they make the testing operations completely automatic, increase the rate of specimen testing, allow exact duplication of tests, largely eliminate the human element, and allow the use of existing equipment with the addition of these accessories.

The Olsen AuTmatic Testing Program Controller contains the controls and circuits for all of the various tests and combinations of tests which it serves. The unit itself operates on mechanical principals, though hydraulic machines are now under development.

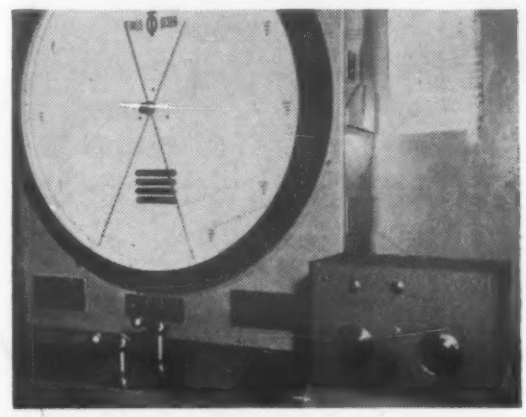
Production Testing—Once set for a given type of specimen tension, compression, or flexure, similar specimens can be tested in rapid succession without further manual adjustment of the controller. When the specimen breaks, the machine is automatically reversed, bringing it back to the start position for the next specimen.

Proof Testing—For proof testing, the controller can be preset to load the specimen at varying speeds with certain stresses, after which the machine automatically unloads in readiness for the next specimen.

Stress (Load) Cycling—This type of test uses the control unit to cycle any prescribed specimen between minimum and maximum loads which can be preset or readjusted between load limits at any time. Both control points are entirely independent of specimen strain and machine elasticity. The load settings and test speeds may be changed at any time during operation.

Strain Cycling—The Program Controller automatically repeats strain applications between zero and the maximum strain range of the instrumentation (extensometer for tension strain). Both control points, which are entirely independent of stress and machine elasticity, may be preset or changed during tests based upon strain requirements in in. per in.

Yield Strength Testing—This function of the controller automatically determines the yield strength of the specimen in production testing by the extension under load method. Once the controls are set, similar tests can be conducted without the necessity of further adjustments.



The Program Controller, containing the controls and circuits for a variety of tests, largely eliminates the human element in materials testing.

Crosshead Cycling—The limits of testing machine crosshead travel during loading and unloading are automatically regulated by the Program Controller function. Two control points precisely establish where the reversals of crosshead motion take place.

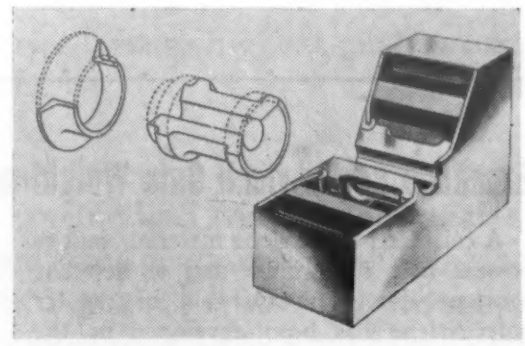
Fastener Serves as Spacer for Sandwich Materials

A specialty fastener called the Kwiko has been developed by the *Shur-Lok Corp.*, Los Angeles, for use in fastening objects to honeycomb material. A two-piece item, the fastener when installed in the material acts as a spacer in supporting the two walls of the structure.

According to the company, it can be installed simply, without special tools, and can be manufactured in many sizes and materials to suit individual specifications.

Among the uses for which the fastener is said to be suited are fastening instruments, seats, shelves, electrical equipment and other similar objects to honeycomb structures.

The Kwiko is designed in two series: the SL20 for use with ordinary AN bolts, and the SL21 for use with 100 deg countersunk head bolts.



As well as providing a fastening load for bolts, the Kwiko also acts as a spacer between the two walls of sandwich material.

High Density Metal Being Marketed

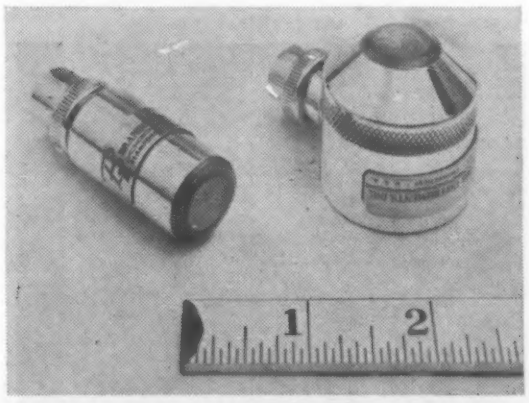
Firth Sterling, Inc., 3113 Forbes St., Pittsburgh 30, has marketed a high density material, the major part of which is tungsten with small amounts of nickel and copper added to aid machinability. It has a specific gravity of 17.5-18.2, and is said to have the tensile strength of a good quality steel.

Typical applications include counterweights, accelerometers, balancing weights, radium caskets, X-ray tube screens, electrical contacts and circuit breakers, gyroscope rotors, oil prospecting devices, vibration dampers, flywheels, and anvils for hot extrusion and upsetting.

Firth Heavy Metal can be supplied up to 20 in. in dia by 18 in. high, or in equivalent volume up to 3500 lb.

New Materials, Parts, and Finishes continued

Tiny Ultrasonic Transducers Probe Thickness of Metal



Small size of transducers allows thickness measurements of unusually shaped metal parts.

A series of ½-in. dia crystal transducers have been marketed for ultrasonic thickness gaging with the Branson Audigage thickness testers, by the *Branson Instruments, Inc.*, 430 Fairfield Ave., Stamford, Conn. The small diameter of these Type B transducers makes possible thickness measurements on metal of sharply tapering sections, compound curvatures, and other unusual conformations.

The instruments employ both quartz and barium-titanate ceramic as active elements and are said to have a sensitivity approximately equal to that of the conventional 1⅜-in. dia, all-quartz probes. They are fitted with quartz wearplates for mechanical protection, are available in either straight or right-angle mountings, and are interchangeable with standard probes.

This type of instrument measures, from one side, the thickness of metals and other homogeneous materials by generating ultrasonic waves which are transmitted into the part by the transducer. At certain frequencies a standing wave is set up in the material, detected by the instrument and indicated on a meter and headphone. They are useful in inspecting ship hulls, tanks, piping and other pressure vessels, and are also finding wide use in production inspection of castings, forgings, extrusions and other metal parts.

Safety Glass Controls Light Transmission in TV Screens

Two companies are now marketing safety glass (sandwich of glass and plastic) which, as well as providing safety for the tube, also improves the clarity of the picture and reduces the glare. The main difference between the two products is that in one the coloring is in the glass itself; in the other in the plastic layer.

Tinted Plastic—By tinting the polyvinal butyral plastic layer between the two sheets of glass a screen is obtained that is neutral in color, but which filters the light, therefore reducing the haze of brightness, gives balance to contrasting shades of light, and makes the picture sharper, claim scientists of *Libbey-Owens-Ford Glass Co.*, 2112-24 Sylvan Ave., Toledo 3, Ohio.

Since many types of tubes are manufactured, there may be variations in the tinting of the new TV screen; therefore, the glass was developed to meet all conditions of manufacture, yet still provide a unit which would absorb certain unwanted light or color bands and emphasize others.

Tinted Glass—Teleglas Duolite, developed by *Pittsburgh Plate Glass Co.*, 632 Fort Duquesne Blvd., Pittsburgh 22, contains a grey tint in the glass itself which allows varying thickness of vinyl plastic in the laminate, and is said to result in a nominal light transmission of 55%.

This grey tint is said to be the same as that in the tube itself, eliminating double reflectance, and according to the company, the glass has successfully withstood implosions of 30-in. circular metal tubes, 27-in. rectangular tubes, and 21-in. glass and metal tubes.

Expanded Polyethylene Cuts Weight and Improves Insulation

A cellular polyethylene material, said to possess half the weight and a dielectric constant about one-half that of regular polyethylene has been developed by the *Bakelite Co.*, 260 Madison Ave., New York 16. According to the company, the new material has been particularly successful in insulating ultra-high frequency television lead-in wires.

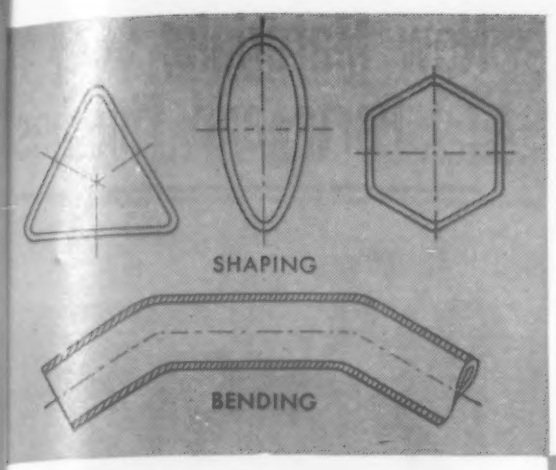
The unicellular polyethylene is expanded with the aid of a blowing agent which produces a material constructed essentially of unconnected cells. With its lower specific gravity and reduced dielectric constant, the plastic is expected to prove useful in applications where weight savings in finished wire construction are necessary and where lower electrical attenuation and line losses are required, particularly at high frequencies.

The material is resistant to water penetration and is said to retain to a large degree the chemical resistance of polyethylene which makes it impervious to corrosion by salt water, most acids, alkalies and oxidizing agents. In extruding the material, the compound is heated and the desirable cellular structure is obtained by the expansion of the gas formed. With the necessary pressure maintained in the extruder and die to prevent over-expansion of the gas, the material expands to twice its usual volume immediately after leaving the die. The amount of expansion can be controlled to the degree desirable for the applications involved.

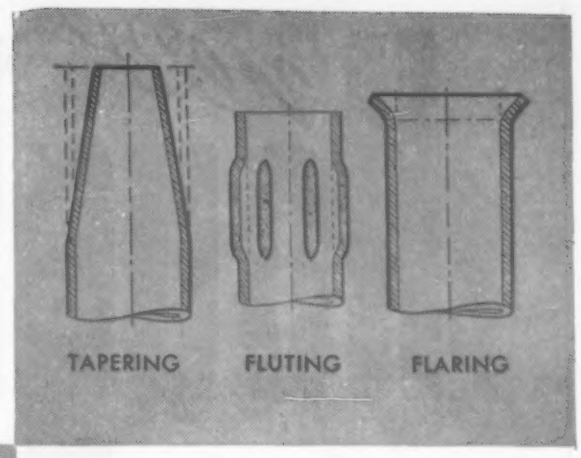
The greater sensitivity of ultra-high frequency television signals to electrical field disturbances that produce noise and distortion in the television picture requires that insulation be built up to include the entire field created between two paired lead-in wires. Moisture, dust and dirt settling on the insulation separating twin wires on low-frequency TV lead-ins, provide a conductive path in the electrical field that causes disturbances at high frequencies. A solid insulating material thick enough to keep moisture and dirt out of the electrical field would be quite high in cost. Cellular polyethylene is said to accomplish this purpose economically because of its expansion, which on a volume basis reduces the cost of the insulation. According to the company, electrical characteristics of polyethylene improve with the new material.

Commercial possibilities are also being explored in the field of flotation equipment, since the cellular polyethylene floats in water much more readily due to its specific gravity of 0.47 as compared to 0.93 for standard polyethylene.

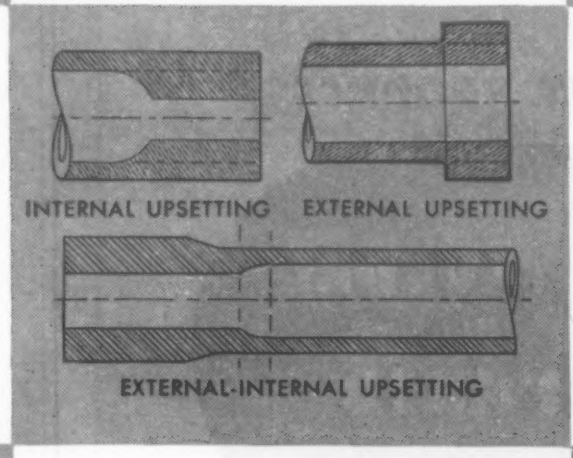
(Continued on page 144)



OSTUCO TUBING is versatile!



OSTUCO TUBING is versatile!



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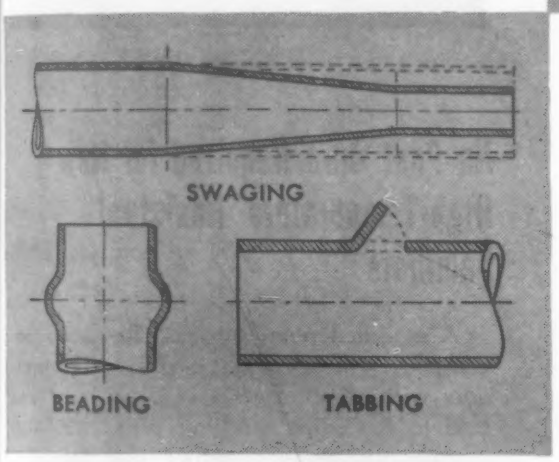
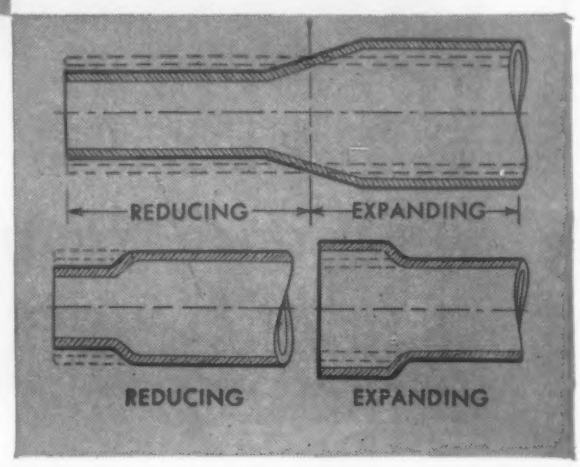


OSTUCO TUBING is versatile!



you draw the blueprint . . . we'll deliver the goods

There's practically no limit to the things OSTUCO can do with Seamless and Electric Welded Steel Tubing to help you produce lighter, stronger, better looking products at lower cost. Only a few of the operations are shown above.

Newly expanded and modernized facilities for *manufacturing, forging,* and *fabricating* tubing, all in one plant — plus our own steel source as a member of the Copperweld family —speed deliveries, assure highest quality and save you money.

Tubing is our business, not a side line. OSTUCO's unique "Single Source" operation, with unified production control, eliminates shipments from one location to another . . . greatly reduces rejects . . . prevents errors . . . puts an end to buck passing and red tape. You write one order, get one bill, and responsibility is clearly fixed. Write for informative catalog, "Ostuco Tubing."

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For more information, turn to Reader Service Card, Circle No. 448

New Materials, Parts and Finishes

No Post Cure Required for New High-Temperature Resistant Laminate

A modified phenolic resin has been developed, which, when used in combination with glass fiber fabrics or mats is said to have the handling properties and curing conditions of other low pressure laminating materials, yet requires no post-curing operation to yield ultimate properties at elevated temperatures.

Developed by the *Narmco Resins & Coatings Co.*, Costa Mesa, Calif., Hi-Temp Conolon 506 is said to be a relatively fast curing phenolic type resin, curing under action of heat to an insoluble, infusible material. It is now marketed in the form of an impregnated "B" stage (partially cured) material.

According to the company, laminates up to ¼ in. thick may be placed in a 350 F press, and removed after a curing cycle of 1 hr at 15 psi pressure. Company tests on several specimens formed in this manner indicated the following physical characteristics of the "B" stage laminating material:

Number of plys	12
Solids (average of 4 specimens)	26.1%
Specific gravity (average of 4 specimens)	1.62
Flexural strength at 77 F (average of 6 specimens), Psi	73,600
Tensile strength at 77 F (average of 5 specimens), Psi	49,660

New Materials, Parts and Finishes

Compression strength at 77 F (average of 5 specimens), Psi ..	37,600
Rockwell M Hardness (average of 6 specimens) ..	106
Flammability	Self-extinguishing

The flexural strength of the specimens gradually decreased with the increase of temperature and length of exposure until when tested after exposure to 500 F for 100 hr, an average of 5 specimens indicated a flexural strength of 15,300 psi.

Storage of the Hi-Temp Conolon 506 impregnated glass fiber fabric should not exceed 6 months at 77 or —5 F. Storage in excess of this period or at higher temperatures will decrease flow characteristics thereby necessitating higher curing pressures. Handling characteristics will also be sacrificed.

Thermosetting Molding Material Offers Improved Arc Resistance

A thermosetting molding material with improved arc resistance and good dimensional stability has been developed by the *Plastics Div., Monsanto Chemical Co.*, Springfield, Mass.

According to the company, Resinox 3700 has an arc resistance measured at 184 sec in standard ASTM tests. Its dimensional stability is said to be such that the problem of after-shrinkage has been virtually eliminated. Other properties claimed for the material are excellent moldability, good transfer molding properties, relatively good impact strength and heat resistance.

Mineral-filled, Resinox 3700 is designed for use in distributor caps, motor control circuits, power transmission circuits, electrical connectors, ignition parts, switch panels and radio tube bases.

(Continued on page 146)

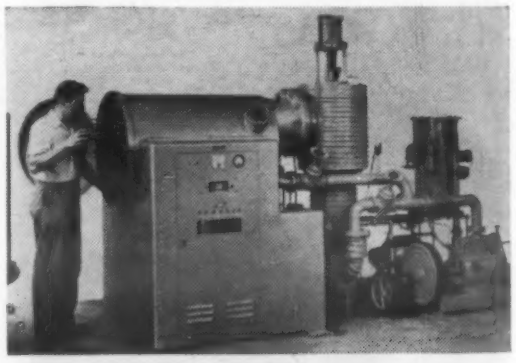
New Materials, Parts and Finishes

Larger Seamless Tubing Now Available

An increase in the size ranges of seamless light-wall tubing from 1¼ in. o.d. maximum to 2-1/16 in. o.d. maximum has been announced by *Superior Tube Co.*, Norristown, Pa.

The new sizes are available in three stainless analyses—AISI Types 304, 321, and 347—and in monel metal. It is produced with a pickled or standard bright finish and in three tempers: fully annealed, half-hard drawn, and full-hard drawn. The length range is from 5 to 22 ft in random, multiple or cut lengths.

Uses for the large diameter seamless tubing include bellows for industrial and aircraft instruments, flexible metal hose for aircraft, food and chemical industries, and low pressure heat exchanger tubes.



New Vacuum Coating Equipment—Both Large and Small

High Production Unit—Designed to meet the needs of the smaller metallizing company, a new 30-in. unit has been marketed by *Consolidated Vacuum Corp.*, 735 Ridge Rd., Rochester 3, N. Y. Called Vacuum Coating Unit type LC1-30, the 30-in. dia horizontal chamber is mounted on a steel cabinet containing the filament power supply, the fixture rotating motor and a door-mounted electrical control panel which opens to aid in maintenance work.

The pumping system, located at the rear of the chamber, includes a high speed 14-in. oil diffusion pump, a small mechanical holding pump and a 100 cfm mechanical pump for roughing and backing. All essential valves, controls and gages for the coating cycle are accessible to the operator as he stands before the viewing port in the side of the chamber.

The unit may be supplied with a stationary fixture for single surface coating or with two rotating fixtures, each of which holds twelve riser rods.

(Continued on page 148)

"hidden strength to give maximum support and stability"

Meehanite Castings Specified

FIG. 2 *Complex Meehanite bed casting requires better properties, superior foundry control.*

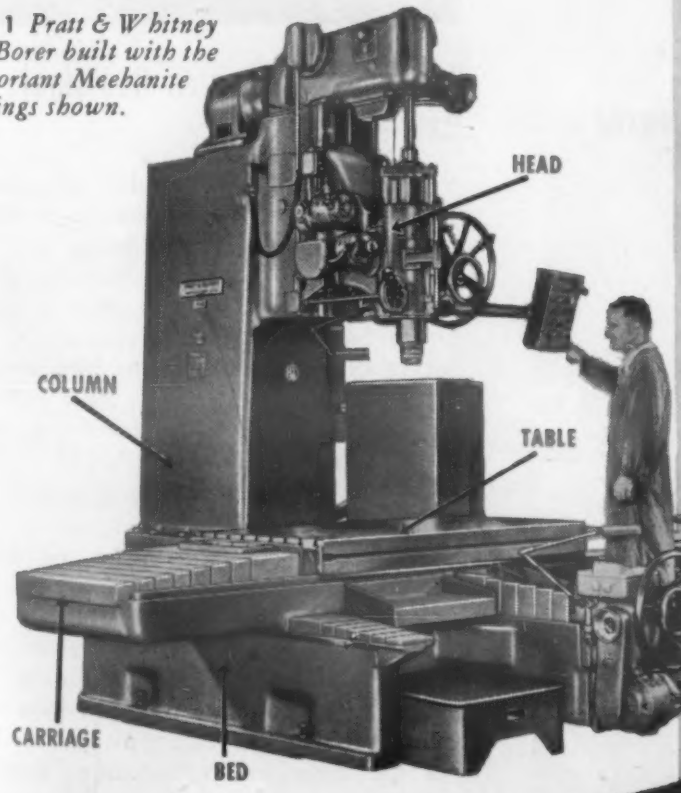


FIG. 1 *Pratt & Whitney Jig Borer built with the important Meehanite castings shown.*

The headline above is a direct quotation. This is what Pratt & Whitney, Division Niles-Bement-Pond Company have to say about their reasons for specifying Meehanite castings for the components of the No. 4E Jig Borer shown in Fig. 1.

The importance of these castings in maintaining accuracy with work loads up to 5,000 pounds is obvious. Each must be properly designed to meet these demands—high strength, uniformity and solidity are essential.

The bed casting shown in Fig. 2 illustrates the complexity of design required for this machine tool. Production of units of this type requires a high degree of control of all foundry process plus the superior engineering properties available in Meehanite castings.

For other applications of Meehanite metal in the Machine Tool Industry, write for a copy of this bulletin. Among its 24 pages you will find many applications which may be of help to you.

MEEHANITE®

714 North Avenue
NEW ROCHELLE, N. Y.

MEEHANITE MEANS BETTER CASTINGS

"Only a MEEHANITE Foundry Can Make MEEHANITE Castings"

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The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington and Dover, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Toledo, O.
Builders Iron Foundry	Providence, Rhode Island
Compton Foundry	Compton, Calif.
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co.	Portland, Oregon
M. H. Detrick Co.	Newark, N. J. and Peoria, Ill.
Empire Pattern & Foundry Co.	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Georgia Iron Works	Augusta, Ga.
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Hardinge Company, Inc.	New York, New York
Hardinge Manufacturing Co.	York, Pennsylvania
Johnstone Foundries Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
Palmyra Foundry Co., Inc.	Palmyra, New Jersey
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
The Prescott Company	Menominee, Mich.
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Warren Foundry & Pipe Corporation	Philipsburg, New Jersey

CANADA

Hartley Fdry. Div., London Concrete Mach. Co., Ltd.	Brantford, Ontario
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario

"This advertisement sponsored by foundries listed above."

For more information, turn to Reader Service Card, Circle No. 465

New Materials, Parts and Finishes

Two Sizes—The *High Vacuum Equipment Corp.*, Hingham, Mass., has marketed two new vacuum metallizing units, one with a 66-in. dia vacuum chamber, the other with a 30 in. The smaller was developed particularly as an inexpensive unit for manufacturers desiring small rapid-cycle operations; the larger is for the production coating of large, hard-to-handle objects.

Hardenable Corrosion Resistant Casting Alloy

A high strength hardenable alloy having corrosion resistance similar to that of 18:8 stainless, is now being cast by the *Donegal Mfg. Corp.*, Marietta, Pa., under a license agreement with the Armco Steel Corp. The Donegal DC-50 casting alloy is essentially the same as the Armco 17-4 PH stainless alloy which previously has been produced in the wrought form only.

The hardness of the alloy is gained by a "solution" heat treatment, either by treating at 1900 F for ½ hr and then oil quenching, or by heating in the temperature range of 850 to 900 for 1 hr, then air cooling. The advantage of the low temperature hardening treatment is that there is no cracking, distortion or scaling problem. In the hardened condition the alloy has a minimum tensile strength of 180,000 psi and minimum yield strength of 165,000 psi.

The DC-50 alloy has the following nominal analysis: Carbon 0.05%, chromium 16.5%, nickel 4%, and copper 4%. Its corrosion resistance is said to be better than that of the 12-14% chromium alloy which is usually employed to obtain similar mechanical properties, and in addition, to good resistance to sea water corrosion and pitting; it is said to be suitable for use where abrasive or bearing conditions exist, such as in ship propellers and pump impellers.

The hardness of the alloy makes it competitive with chromium-cobalt-tungsten alloys for cast high grade pumps, valves, and similar components which are subject to wear.

(Continued on page 150)

New Materials, Parts and Finishes

The alloy is said to be readily machinable in the solution annealed condition, and when hardened has appreciable ductility and toughness in addition to its strength properties. Other uses for the alloy are in structural high strength parts for aircraft, and for thrust bearings in all types of applications.

The physical properties of the alloy are as follows:

	Solution Treated 1900 F-½ hr oil-quenched	Hardened 850-900 F-1 hr air-cooled
Ultimate Strength, Psi (tension)	135-165,000	180-210,000
0.2% Yield Strength, Psi (Tension or compression) ...	95-125,000	165-200,000
Elongation in 2 in., %	6-15	6-15
Reduction of Area, %	30-60	30-60
Izod Impact, Ft-Lb ...		10-20
Hardness Rockwell, Brinell		C40-45, 375-440

New Fast-Setting Glue

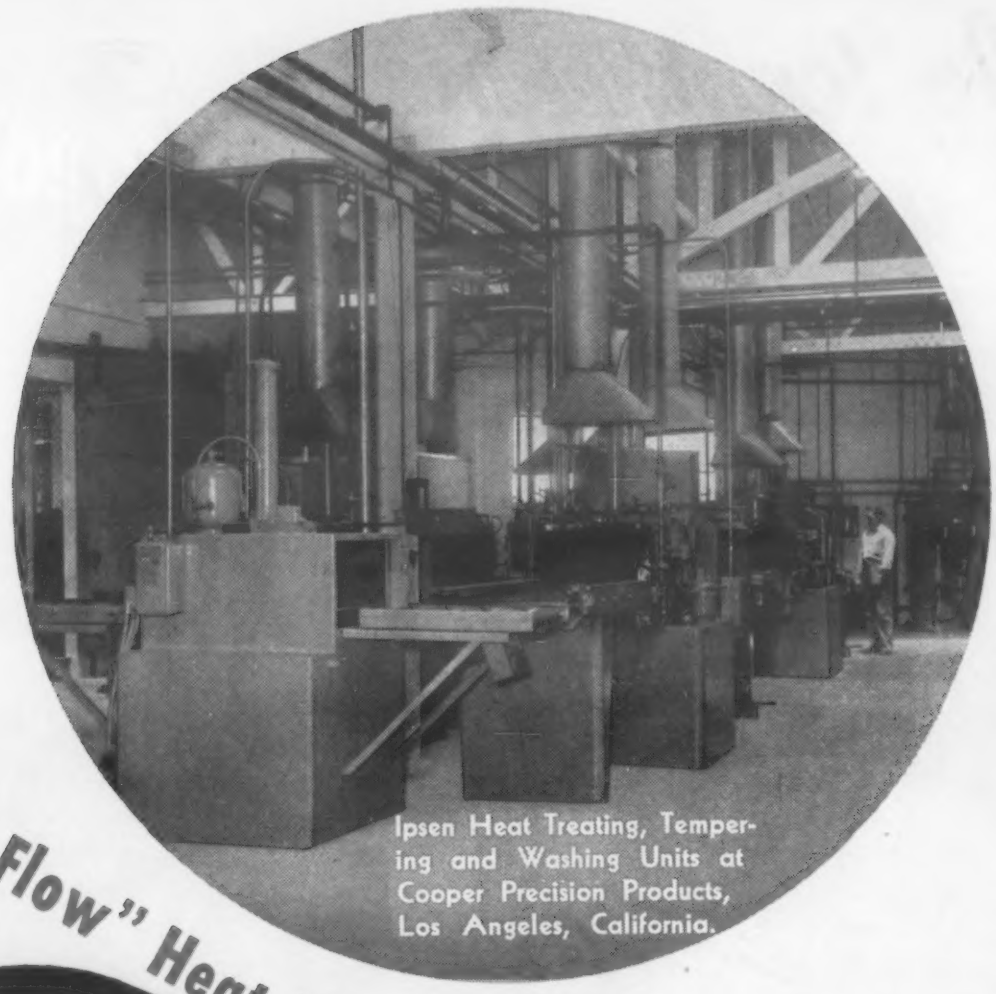
A new glue, Weldwood Presto-Set, is said to bond, quickly and firmly, a variety of porous materials. Developed by *United States Plywood Corp.*, 55 W. 44th St., New York 36, this polyvinyl ("white") liquid adhesive is said to set, ready for machining, in 30 min for soft woods and somewhat longer for hard woods.

According to the company, it permanently bonds wood, hardboard, cloth, leather and paper in any combination. It is also said to be effective for repairing porcelain objects and, when properly diluted with water, for putting a preserving film on maps or pictures, since it is colorless when dry.

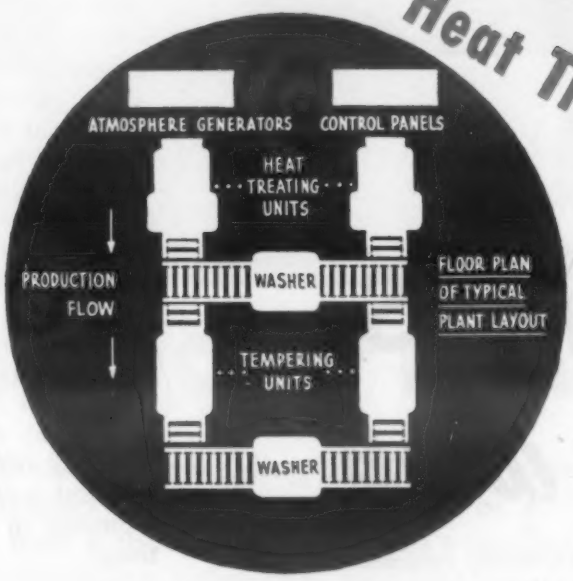
The glue is available in 1-½ and 3-½ oz tubes; pint, quart and gallon jars and 5, 10, 30, and 55 gal drums.

(Continued on page 152)

How IPSEN "Production Flow" Heat Treating Reduces Work Handling



Ipsen Heat Treating, Tempering and Washing Units at Cooper Precision Products, Los Angeles, California.

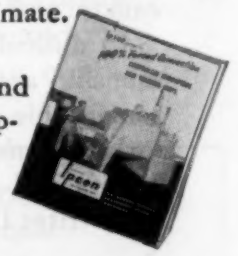


NOW with Ipsen Units, you can modernize your heat treating department, improve quality and cut costs! Each self-contained Ipsen 100% Forced Convection Heat Treating Unit can harden, carburize, carbon restore or carbonitride. When used with Ipsen Washers and Tempering Units, connecting roller sections permit uninterrupted movement of work load through all units at furnace level.

Ipsen Automatic Heat Treating and Tempering Units have complete cycle and atmosphere control for uniform results and for bright and absolutely scale free work. Straight-through design of Ipsen equipment gives you maximum efficiency in work handling.

Send Samples—You'll want to know how heat treating the "Ipsenway" can be applied to your work. Send samples of your work for processing and for a cost estimate.

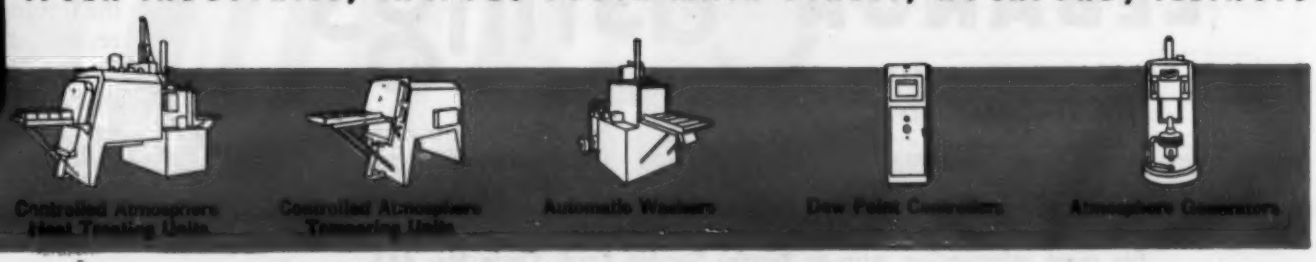
Write for new literature — illustrating and describing the complete line of Ipsen equipment, including new Automatic Dew Point Controller.



AUTOMATIC Ipsen HEAT TREATING UNITS

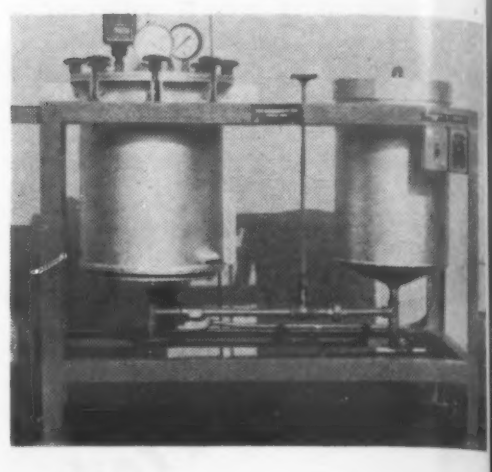
Universal Production Units in Standard Sizes–100 to 2,000 Lb./Hr.

IPSEN INDUSTRIES, INC. 720 SOUTH MAIN STREET, ROCKFORD, ILLINOIS



For more information, turn to Reader Service Card, Circle No. 364

New Materials, Parts and Finishes



New Vacuum Impregnation Unit

The *High Vacuum Equipment Corp.*, Hingham, Mass., has marketed a new vacuum impregnation unit consisting of a combination vacuum-pressure vessel in which the impregnating takes place and a built-in reservoir on the same frame for storage of the impregnant.

The impregnating tank is jacketed and operates at temperatures up to 300 F to meet the requirements of the impregnating material. Hot spots, which are sometimes encountered with contact heaters, are eliminated since electrically heated vapors circulate within the jacket of the tank, heating the impregnating tank evenly throughout its length.

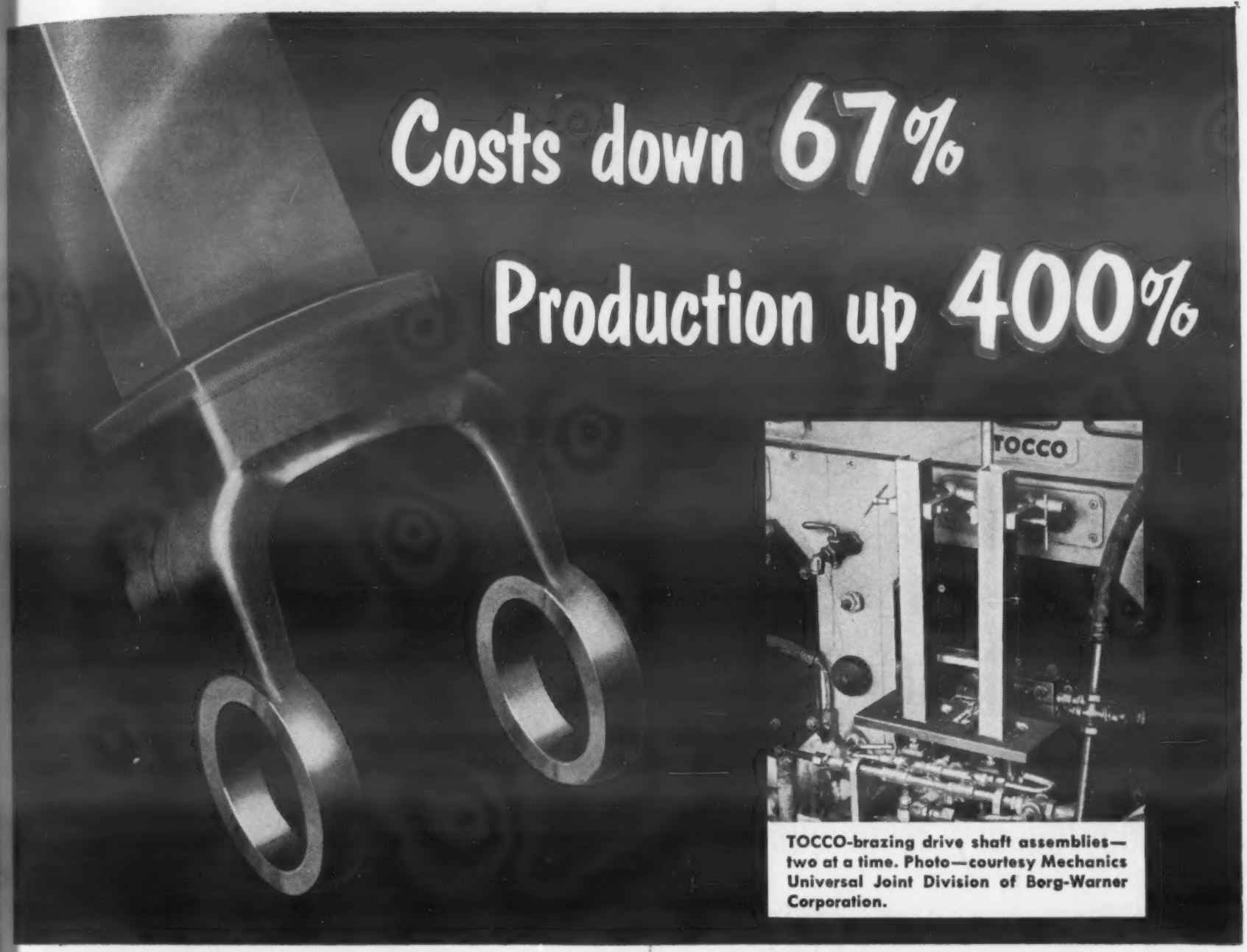
According to the company, the unit is suitable for impregnation of rotors, stators, motor windings, condensers, capacitors and other types of electronic and electrical equipment that must be made according to joint Army-Navy Specifications.

Wet Burnishing Cuts Costs and Hazards

A new method of wet burnishing designed to improve conventional polishing and buffing procedures has been developed by *Gerity-Michigan Corp.*, Adrian, Mich. It consists of revolving rubber mats which operate in a wet abrasive slurry. The parts to be burnished are advanced through the slurry on a carrier moving in a circular or other enclosure.

The company estimates that fabric polishing and buffing wheels last about 5 to 15% as long as the rubber fingered mats used on the Ger-O-Matic machines, and the compounds in the abrasive slurry are reused again and again with little loss. Due to the use of an abrasive slurry, dust is eliminated, reducing fire and health hazards and making elaborate exhaust systems unnecessary.

(Continued on page 154)



TOCCO-brazing drive shaft assemblies—two at a time. Photo—courtesy Mechanics Universal Joint Division of Borg-Warner Corporation.

with TOCCO* Induction Brazing

The shift from welding to TOCCO* induction brazing of the drive shaft assembly pictured here is typical of savings accomplished by TOCCO in over a thousand of America's leading metal-working plants. If you have brazing, soldering, heat-treating or heating for forming or forging operations in your plant TOCCO can probably save you money too.

COSTS DOWN 67%—Mechanics Universal Joint Division of Borg-Warner reports a 67% cost reduction in TOCCO-brazing yokes to tubing in the manufacture of power transmission shafts. Formerly, parts were hand-welded.

PRODUCTION UP 400%—Automatic TOCCO increases production from 11 to 45 pieces per hour—400% faster than former method. In addition TOCCO-brazing produces a cleaner, neater joint than possible with previous method.

TOCCO Engineers are glad to survey your plant, without obligation, of course, to determine where TOCCO Induction Heating can speed your production and cut your manufacturing costs.

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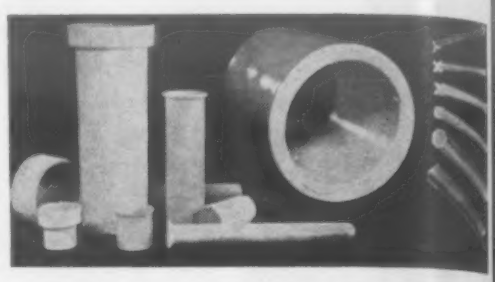
For more information, turn to Reader Service Card, Circle No. 366

New Materials, Parts and Finishes



Opaque Silica Rod and Tubing

Regular shapes, close tolerances and thoroughly glazed surfaces are claimed for a line of opaque silica rod and tubing of various diameters and wall thicknesses now being manufactured by the *Quartz Products Corp.*, 25 Crows Mill Rd., Keasbey, N. J.

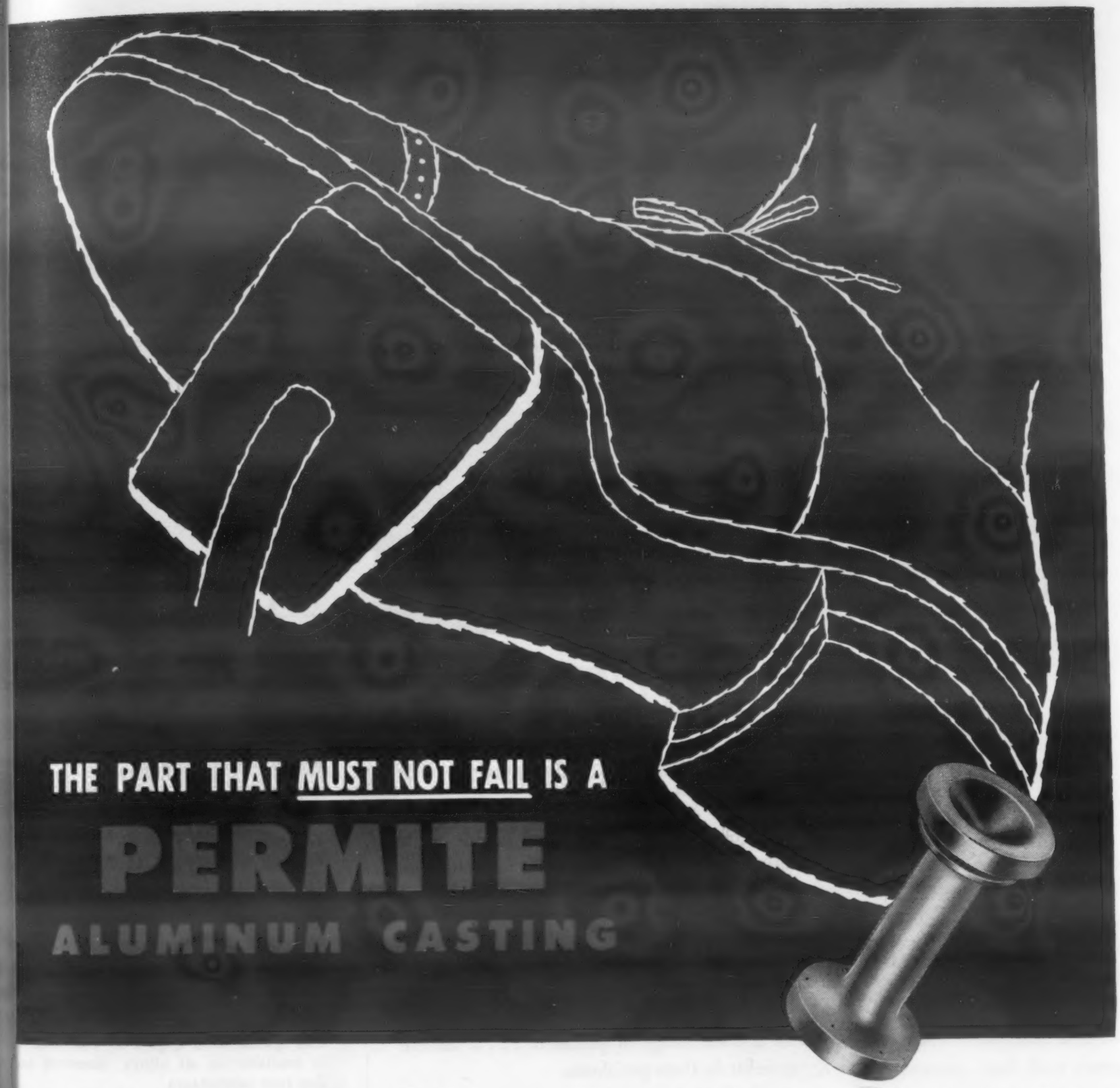
According to the company, the smooth surfaces and dimensional uniformity are important in minimizing devitrification at high temperatures. Closer tolerances as to bore and wall thickness are said to allow the use of the material in applications for which it was previously considered impracticable.

Portable Hardness Tester for Sheet Metal

A precision type sheet metal hardness tester, Model 317, for testing ferrous and non-ferrous sheet metal has been marketed by the *Pacific Transducer Corp.*, 11921 W. Pico Blvd., Los Angeles 64.

According to the company, readings can be obtained to within 2 points on the Brinell scale with the use of a calibrated microscope and reticle. The microscope has a self-contained battery-type illuminator. Sheet stock in thicknesses from 0.010 to 0.250 in. can be tested.

The instrument utilizes a 1/8-in. dia ball with 150 kg load. A spring which



It's a fact! In 90% of all cars, trucks, and buses on the highways today, the master cylinder brake piston is a Permite Aluminum Alloy Casting, made by the permanent mold process by Aluminum Industries, Inc.

Yes, for the one vital part that *must not fail,* automotive manufacturers turn to Permite, because ever since the early pioneering days of the use of aluminum, Permite Aluminum Castings have enjoyed a reputation for highest quality.

Component parts made of Permite Aluminum Castings, permanent mold and sand cast, are contributing to faster machining, speedier production, lower costs in all divisions of the metalworking industry. If you want castings of assured structural strength, accurate in design and dimension, free of hidden defects, castings that will sharply reduce your reject rate, consult with Permite engineers on your requirements. Send blue prints for recommendations and quotations.

ALUMINUM INDUSTRIES, INC. • CINCINNATI 25, OHIO

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PERMITE **Aluminum Castings**

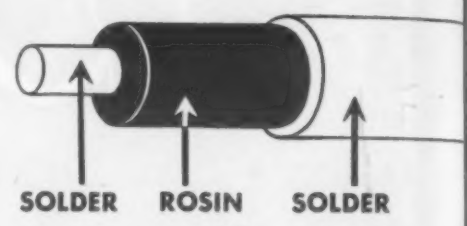
ALUMINUM PERMANENT MOLD and SAND CASTINGS . . . HARDENED, GROUND and FORGED STEEL PARTS

For more information, turn to Reader Service Card, Circle No. 314

New Materials, Parts and Finishes

holds the ball is said to remain in constant calibration. Pressure on the sh is applied by a pair of parallel jaw plie and the indentation formed is measur with the miscroscope directly on t Brinell scale. A limiting pad is incorp rated which forms all indentations wi the same load.

The instrument is designed for use warehouses, factories, metallurgical la oratories, and wherever it is necessary test the hardness of metals.



Novel Construction Claimed for Rosin Filled Solder

Speed in soldering is said to be one the features of the Cen-Tri-Core Ros Filled Solder marketed by *Alpha Meta Inc.*, 56 Water St., P. O. Box 34 Berg Station, Jersey City 4, N. J. A solder wi is coated with rosin, over which is form the outer solder sleeve, eliminating ros voids, the company claims.

Simultaneous wetting, flow and take a said to be characteristics of the materi and the rosin is non-corrosive and el trically non-conductive. It conforms to Fe eral Specification QQS-571b, Par. E-2a. is available in all alloys, diameters a flux core percentages.

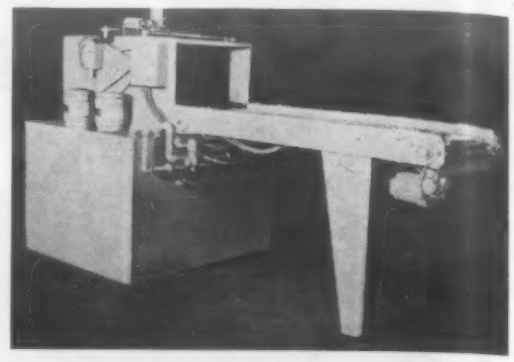
Cleaning Concentrate Speeds Action of Solvents

Brulinsolv Concentrated Solvent Emu sion Cleaner, when mixed with low co solvents such as kerosene is said to great speed the cleaning action of the solven Marketed by *Brulin & Co., Inc.*, 29 Columbia Ave., Indianapolis, Ind., th concentrate is said to be safe to use, non toxic, non-corrosive and free of chlori ated or phenolic compounds.

According to the company, it is recom mended for cleaning machinery and equip ment, aircraft surfaces, painted or u painted concrete floors, and it is said t be safe enough for use in cleaning greas tar or oil from hands.

(Continued on page 158)

New Materials, Parts and Finishes



Automatic Brine Quench Unit Speeds Metal Quenching

A self-contained brine quench unit is said to feature automatic transfer of work load from adjoining heat-treating furnace through its own brine quench. Developed by *Ipsen Industries, Inc.*, 715 S. Main St., Rockford, Ill., the unit has been developed for use with Ipsen series T, metal treating furnaces.

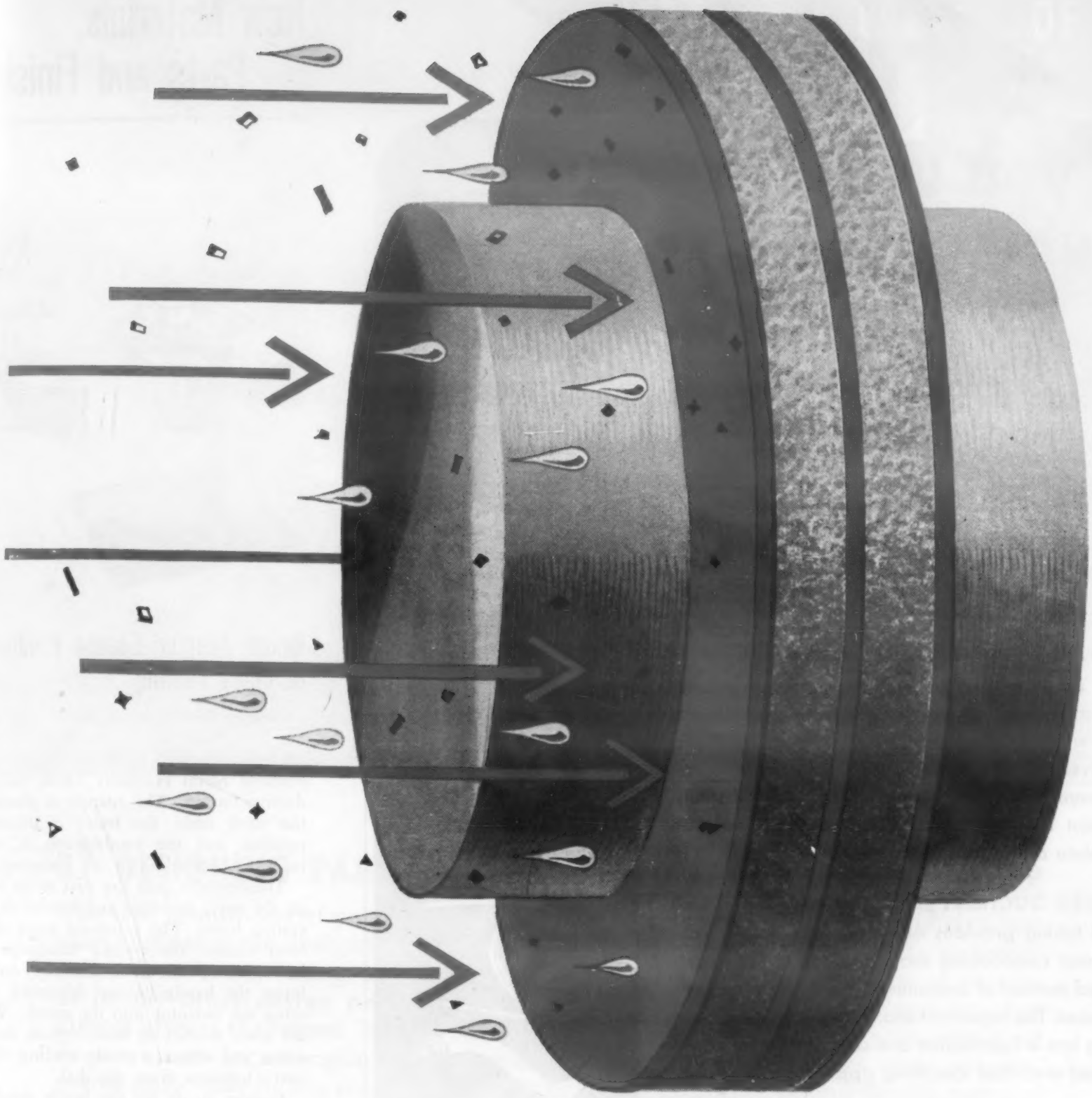
Made of welded steel, the brine quench is available in load capacities of 300, 400, and 700 lbs. Solution temperatures, work handling and solution circulation are all controlled automatically by presettings on controls built into the regular furnace control panel. Temperature of the solution is controlled by immersion-type, finned cooling coils through which tap water passes. A Partlow temperature control maintains the proper temperature of the solution. The loader section of the unit also serves as a roller-type unloading platform.

When floor mounted, the brine quench unit is located approximately 8 in. from the quench zone at the rear of the Ipsen series T furnace. The brine quench begins operation upon completion of the furnace heating cycle. As the intermediate door of the furnace closes, the rear door opens and chain-driven rods from the new unit automatically move into the furnace quench zone, contact the load with cam actuated arms and pull the work tray to the brine tank where the tray is immersed. After a preset period, the quench rack is raised and the work tray can be removed manually from the unit.

The quench rack is held, immersed, and raised automatically by an air cylinder. As the load lowers into the solution, four motor driven propellers begin rapid circulation of the solution over the cooling coils, providing uniform cooling of the brine solution.

Tap water enters the cooling coils through a magnetic water valve located under the loader section at the rear of the unit. Water passes through the cooling coils and flows out through pipes connected to the coils. Salt or sodium hydroxide and water are placed in the tank manually.

(Continued on page 160)



"WORK CLOTHES" SOLVE TOUGH SEALING PROBLEMS

American Felt Company

TRADE MARK

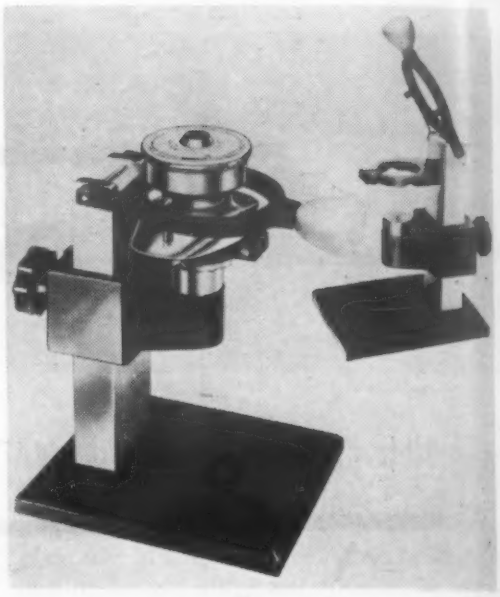
GENERAL OFFICES: 24 GLENVILLE ROAD, GLENVILLE, CONN.

SALES OFFICES: New York Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, San Diego, Montreal — PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I. — ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.

Seal off your sealing worries with felt "work clothes!" Above is an OilFoil seal, used as protective "work clothes" in many machines. It consists of two layers of felt, bonded with three septums of Hycar, the synthetic rubber-like substance that is impervious to and unaffected by oils, greases and the hydrocarbons used in hydraulic systems. Such washers can have one, two, or three septums, to keep fluids in and seal out water, dust, dirt, gases, and retain pressures. If there is no enclosed lubricant, the felt can be impregnated with oil or grease, to provide long-time lubrication. OilFoil seals are supplied cut to exact dimensions, ready for assembly. For more information, write for Data Sheet No. 11, "Felt Seals, Their Design and Application."

• For more information, turn to Reader Service Card, Circle No. 329

New Materials, Parts and Finishes



Bench Adapter Speeds Production Hardness Testing

Newage International, Inc., 235 E. 42nd St., New York 17, has marketed a bench adapter designed to accommodate their Portable Metal Hardness Tester for production testing. The adapter is placed on the work table, the tester is placed in position and the combination is ready for work, according to the company.

The operator puts the part to be tested on the anvil provided and lowers the operating lever. The extension arms of the lever contact the tester's handgrips and by applying an even pressure on the lever, the handgrips are depressed, lowering the indentor into the metal. Wher the lever reaches its lowest point the operator can obtain a direct reading of the part's hardness from the dial.

Custom anvils for the bench stand can be designed on request for special sizes and shapes.

Industrial X-Ray Film Shows Minute Detail

A new ultra-fine grain industrial x-ray film, Type 510, has been developed by the *Du Pont Photo Products Dept., E. I. Du Pont de Nemours & Co.*, Wilmington, Del. According to the company, the new film can be used at low voltages (10-20 peak-kv) to examine low-opacity materials, such as aluminum, magnesium, corn and wheat. With million-volt x-ray or betatron equipment, it may be used to examine steel up to 3 in. thick.

The new film can be used to particular advantage on subjects where very minute detail is desired, since the fine grain emulsion permits detection of tiny flaws

For more information, Circle No. 484 ➤

BY DESIGNING PARTS TO BE *PRESSED FROM BRASS POWDER*

The tens of millions of powder metallurgy brass parts in use today are evidence that alert engineers can design this proven material into many products which previously called for a brass casting, stamping, or machined part. In designing parts of brass—as in any other design problem—price is rarely the first factor to consider—but almost always the *second.* It's QUALITY you consider first. Will the part meet your requirements for strength, density, color, accuracy of size . . . meet these requirements uniformly by the tens of thousands or by the millions? Bound Brook, pioneer in powder metallurgy can answer your quality questions . . . then, if your requirements are for volume . . . can usually quote a price that means a substantial saving . . . and can make delivery, as promised, to keep your production line moving. For authoritative answers on your questions about powdered brass, bronze, or iron parts . . . or bronze or iron bearings . . . write or wire Bound Brook direct or telephone your nearby Bound Brook man.

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Pioneer in

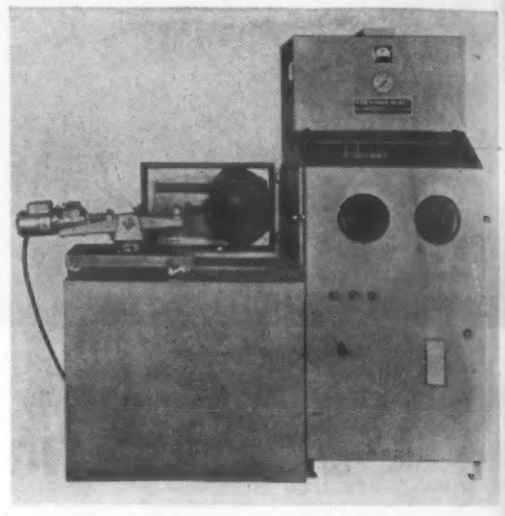
POWDER METALLURGY BEARINGS & PARTS

New Materials, Parts and Finishes

in, for example, spot-welding in aluminum sheeting. The same is true for the detection of foreign contamination in grain prior to milling, a relatively new use of x-rays.

Since it is made for radiography applications where minute detail is more important than speed, the new film is only approximately 1/3 as fast as Du Pont Type 506 Industrial X-Ray Film.

Type 510 is designed for use without calcium-tungstate intensifying screens and is available in all standard sizes, packaged as "NIF" non-interleaved film.



New Wet Blasting Machine

A new model wet blasting machine known as the Pressure Blast Roto-Barrel has been marketed by the *Cro-Plate Co., Inc.*, 747 Windsor St., Hartford, Conn. The unit was designed for the bulk, high-production-rate finishing, cleaning or deburring of small parts such as screw machine products, stampings, small castings and extrusions, and precision machined components.

The work is loaded into the expanded metal, plastisoled barrel and rolled into the cabinet where the blast gun, in a fixed but adjustable position, is aimed in the open end. In the case of some types of parts, where manual operation is necessary, armports and knee-actuated triggers allow the operator to manipulate and actuate the easily removable gun. A variable speed drive rated at 0-78 rpm rotates the barrel exposing the parts to the blast stream.

Following the wet-blasting operation, the barrel is manually rolled out of the cabinet and the work is rinsed in the rinse facility on the stand. The drive, shaft and barrel swivel can be raised or lowered.

The machine is made of stainless steel throughout, and no pumps are employed in the blast system. Two blast circuits are available, either regular velocity or high velocity.

(Continued on page 164)

For more information, Circle No. 396

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Finishing touches are applied to a die made of Cr-Mo-W (Chrome-Moly-Tungsten) at extrusion plant of Kaiser Aluminum & Chemical Corp.

The operator calipers die blank, made of Cr-Mo-W. This long-wearing, air-hardening steel, easy to machine, has good shock resistance.

. . . . . .

BETHLEHEM TOOL STEEL ENGINEER SAYS:

To Reduce Tool Failures Always Remove the "Feather" Edge

After tools are ground, a rough "feather" may often be found along the working edges. If this feather is permitted to remain, the chances are good that the cutting edges will dull prematurely. Or the tool may even fail after brief service. For best results it is advisable to remove these surface irregularities immediately after grinding. This is especially true of cutting tools. We know several shop men, each of whom makes it a point to carry a pocket stone, just for this use. When a feather is noticed, out comes the stone. This worthwhile precaution results in longer tool life, and greater shop economy.

Why they chose this Hot-Work Steel for Aluminum Extrusions

They wanted a hot-work steel with great resistance to wear, capable of withstanding severe shock and drastic changes in temperature, and with the ability to provide trouble-free service in long production runs. And it's for those reasons that the die specialists at the busy extrusion plant of Kaiser Aluminum & Chemical Corp., located at Halethorpe, Md., are well pleased with the performance of Cr-Mo-W (Chrome-Moly-Tungsten) for the manufacture of aluminum extrusions.

Bethlehem Cr-Mo-W, a general-purpose type of hot-work tool steel, has a 5 pct chromium content, plus moly and tungsten. It is especially suited for jobs that involve shock or radical temperature changes, and for all applications where heat-checking is a problem.

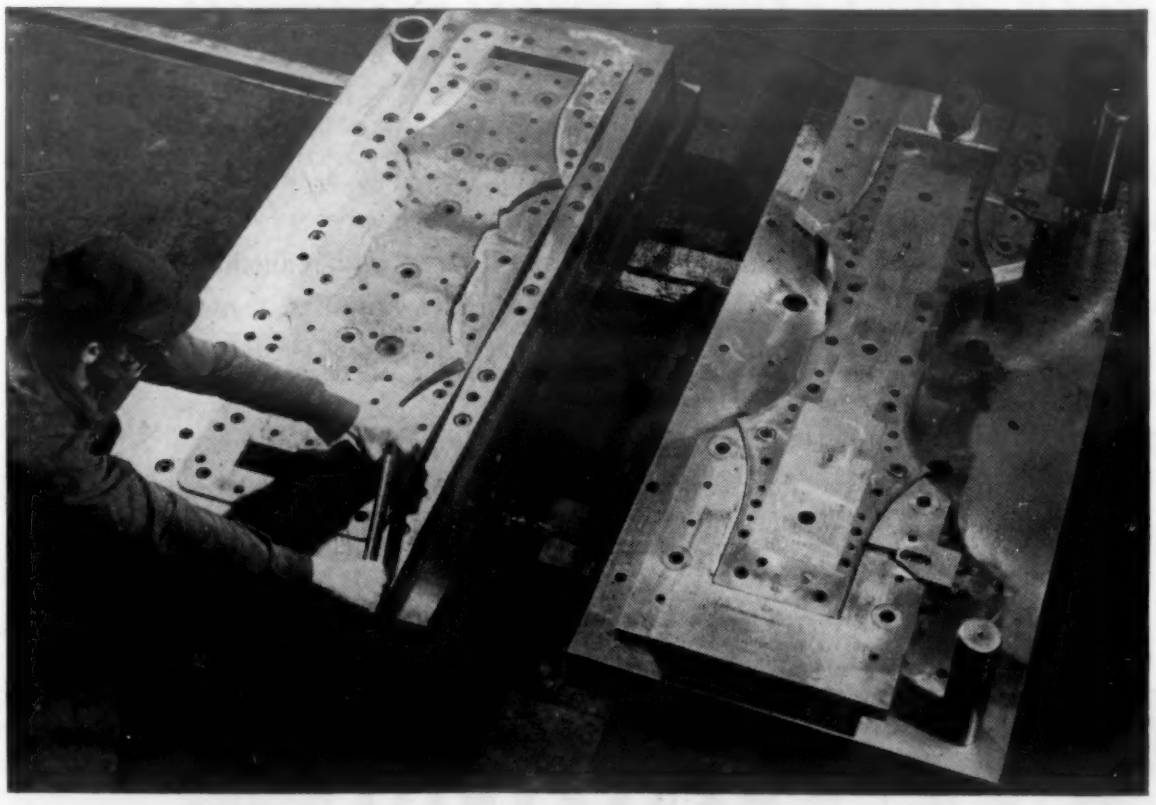
Cr-Mo-W hardens in air. It has good red-hardness, and fine resistance to distortion during heat-treatment. It is an easy steel to machine because it can be annealed to 217 Brinell.

TYPICAL ANALYSIS

Carbon	0.35	Tungsten	1.55
Silicon	1.05	Molybdenum	1.65
		Chromium	5.00

Cr-Mo-W withstands severe impact on such highly-stressed parts as trimmer dies, die-casting dies, bolt-gripper dies, hot-shear blades, and various types of punches.

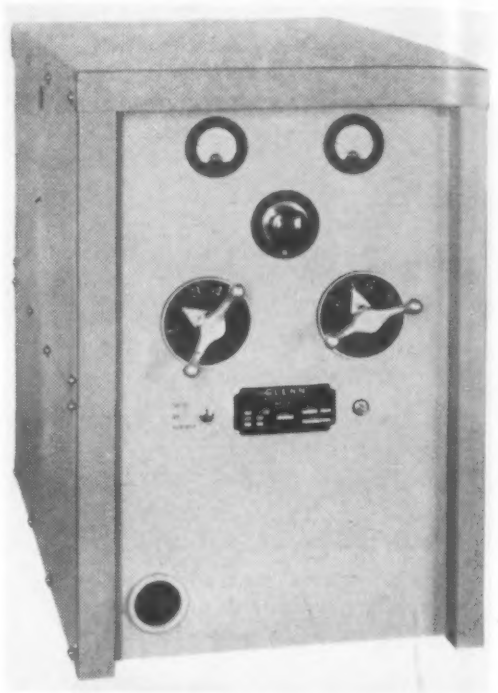
If you have a job calling for a hot-work steel able to take shock and wide changes in temperature, and hold its dimensions through long production runs, give Cr-Mo-W a tryout. You can get full information, and quick delivery, from the nearest Bethlehem tool-steel distributor.



DIE TO BLANK DIFFERENTIAL HOUSINGS

This large die, made of A-H5, is used in the cold blanking of sheet steel for the manufacture of truck and automobile differential housings. A-H5, another Bethlehem 5 pct chrome air-hardening grade, with 1.00 pct carbon, is used for this application because of its wear-resistance, and easy machinability.

New Materials, Parts and Finishes



New Multi-Purpose Constant Voltage Welder

A 1000 amp rectifier-type d.c. welder, designed specifically for powering submerged arc, inert gas (Sigma) and other types of automatic welding processes has been marketed by the *Glenn Co.*, 3134 E. 10th St., Oakland 1, Cal.

The Model 1000UV-40 has a variable pre-set arc voltage range of 18 to 42 v; operates on 3 phase, 60 cycle a.c. power, 240 or 480 v; and its efficiency is said to be 85% with a power factor of 90%.

The "stepless" arc voltage range permits the use of the unit for submerged arc, inert gas, and hand-operated automatic welding processes, as well as for automatic stud welding and compressed air-carbon arc cutting and gouging operations.

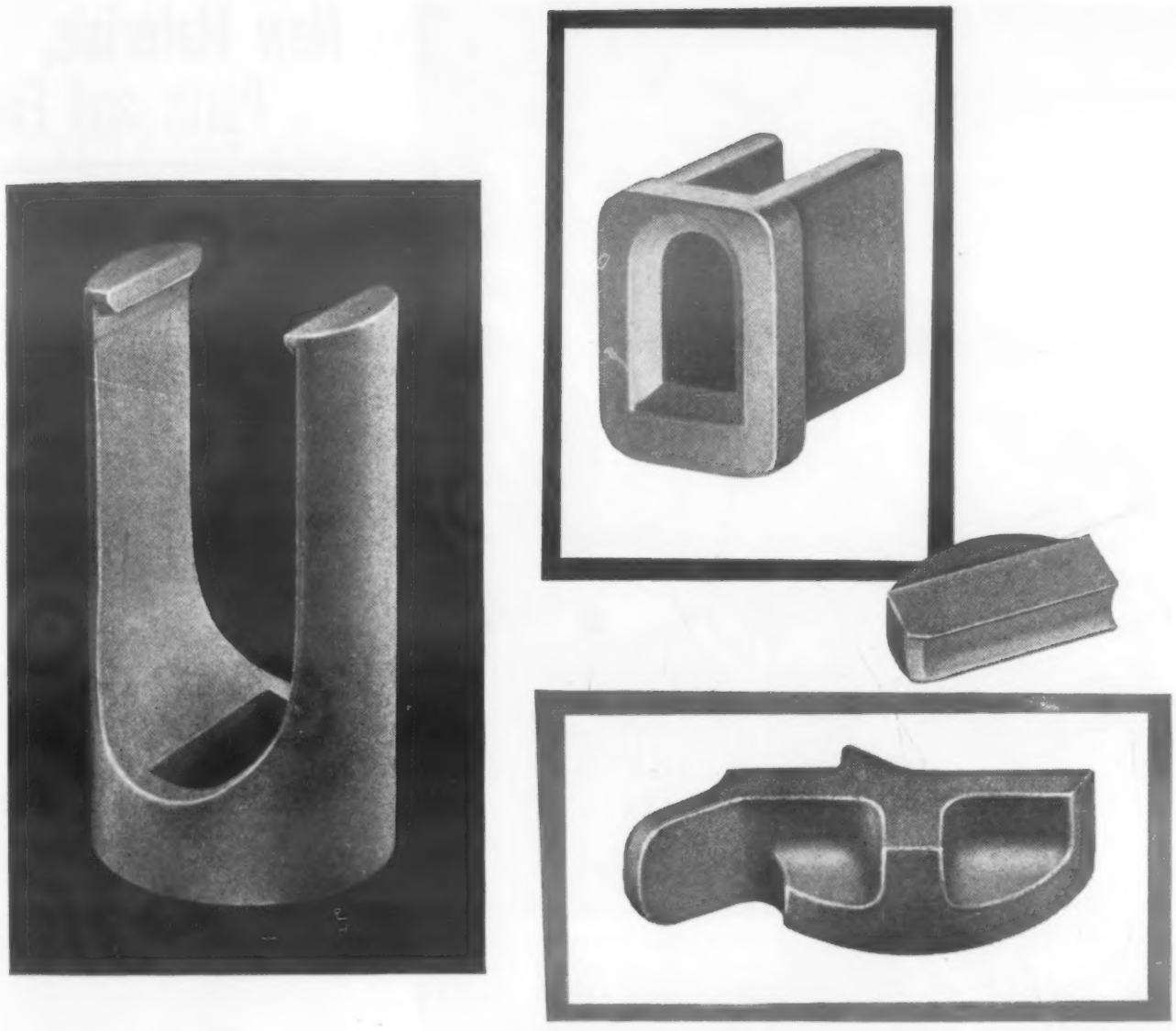
No Iron Needed for Soldering Paste

All-State Welding Alloys Co., Inc., 249-55 Ferris Ave., New York, has marketed a soldering paste compounded of flux and solder which is applied cold then heated, by any means, to 375 F to seal, join or tin most common metals except aluminum.

According to the company, tests on tubing work show that tests to destruction (up to 6500 psi) failed to break the soldered joints.

(Continued on page 166)

For more information, Circle No. 332



improve product design . . .

cut manufacturing costs

with ACCUMET PRECISION INVESTMENT CASTINGS

In many cases design is restricted and function limited when alloy steel parts are made on conventional machinery from bar stock or forgings. Frequently such designs can be improved and production costs lowered by the use of precision investment castings. That's because this casting process permits the use of high alloy steels that are difficult to machine or forge.

Take these four component parts of a pneumatic tool for example. They are Accumet Investment Castings made by Crucible of 8620 steel. They have a smooth, satiny finish and are held to very close tolerances. If these parts were not made by this "lost wax" process, the pneumatic tool could not be produced at a practical cost in its present design.

Crucible engineers and metallurgists are available to help solve design and production problems through the use of Accumet Precision Investment Castings. Write now, and let them help you solve yours.

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first name in special purpose steels

54 years of Fine steelmaking

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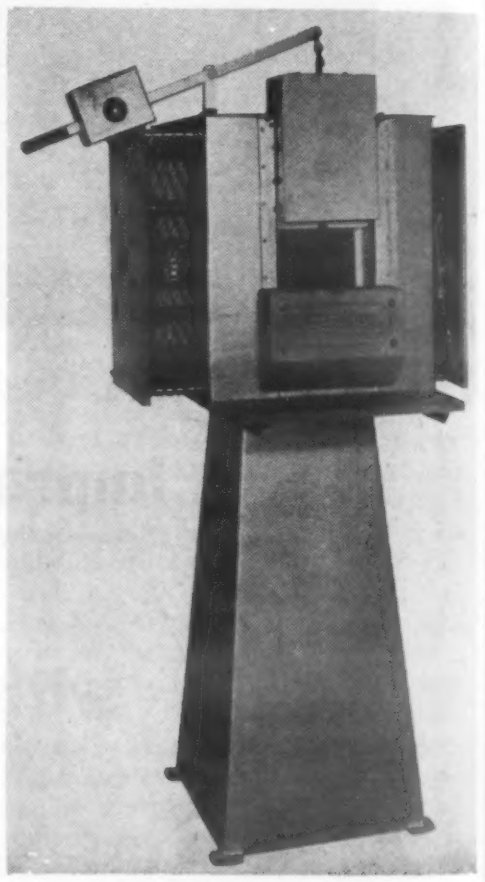
REX HIGH SPEED • TOOL • REZISTAL STAINLESS • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

For more information, turn to Reader Service Card, Circle No. 398

New Materials, Parts and Finishes

The paste is expected to find application in wire assemblies, radiator work, tinning of utensils, internal tinning, sheet metal work, tubing work, auto body repairs, and when formulated with an alcohol-resin flux, a wide range of electrical work.



Small Furnace for Hardening Steel

Improved performance and stability of the Model Y high speed steel hardening furnace are claimed to be results of redesigning. Improvements of the furnace, manufactured by the *Sentry Co.*, Foxboro, Mass., include close regulation of heat at the operating range, rapid heating to desired temperature, increased operating economy, and a welded plate base for greater floor support. Silicon carbide resistors located above and below the one-piece silicon carbide muffle chamber supply the heat.

The furnace door is a monolithic refractory unit which raises and lowers in a path set by guides. A counterbalanced lever arm operates the door which will remain in any desired position.

The unit is designed specifically to permit use of the Sentry diamond block method of atmospheric control which automatically generates a protective atmosphere inside the work chamber.

Contents Noted

A digest of papers, articles, reports and books of current interest to those in the materials field.

This Month:

- *Temperature Effects on Certain Metals*
- *The Mechanisms of Fretting Corrosion*
- *Proposed Revisions in Pressure Piping Standards*
- *Testing the Hardness of Plastics*

What Happens to 12% Chromium Alloys at 1000 F Temperatures?

With the extremely high operating temperatures encountered in this jet age, the interest of engineers and metallurgists has become increasingly centered around the effect which these temperatures have on the properties of the structural alloys used. In the manufacture of steam and gas turbines and in jet engines one of the most widely used medium alloys is the 12% chromium steels. Now, due to the critical requirements of the more strategic austenitic steels, there has been considerable interest in the modifications of this class of alloy to gain the specific properties desired.

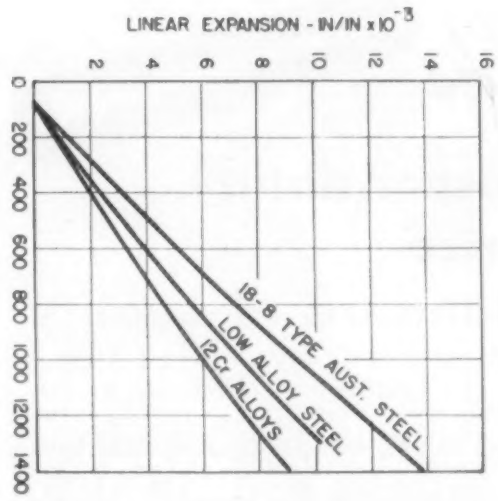
In a paper given at the annual meeting of The American Society of Mechanical Engineers, Dec. 1953, D.L. Newhouse, B.R. Seguin and E.M. Lape of the G-E Materials and Processes Lab. discuss some of the important static properties of the 12 Cr (Type 403) alloy and six alloy modifications (12 Cr-Co-W-V, 12 Cr-W-V, 12 Cr-Mo-V, 12 Cr-Mo-W-V, 12 Cr-Cb, and 12 Cr-Ni-W) at service temperatures of 900 to 1200 F.

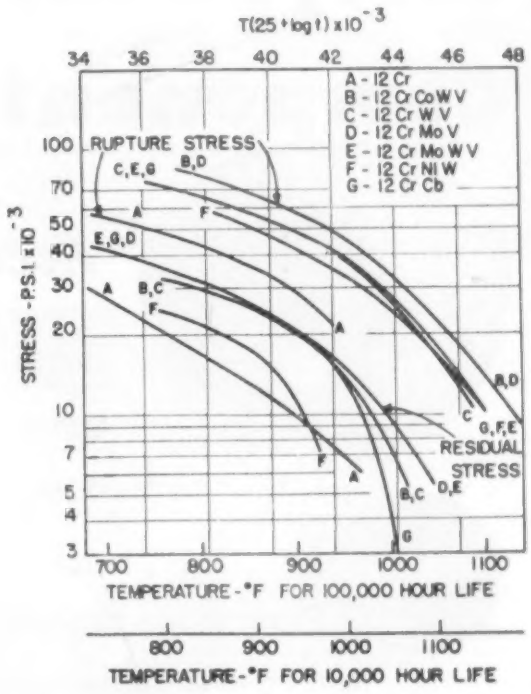
In heat treating the alloys, it was found that a solution heat treatment of 1750 to 1800 F was generally most satisfactory for the 12 Cr-Co-W-V material, approximately 1900 F for the 12 Cr-W-V and 12 Cr-Mo-W-V alloys, and 2000 F for the 12 Cr-Mo-V and 12 Cr-Cb steels.

Since the relative thermal expansion of materials at these high temperatures is very important particularly where joining is concerned, the authors show average thermal expansion curves for three major types of steel (Fig 1). It can be seen that the 12 Cr grades at 1000 F have almost as great a deviation below low-alloy steel as do the 18:8 above, so that where the joining of two of these types is necessary, design allowances must be made in order to eliminate critical stressing.

Though actual test results differed as to change in modulus of elasticity at elevated temperatures, there is general agreement that the tensile modulus at 1000 to 1050 F is 30 to 35% lower than at room temperature for these alloys.

In evaluating rupture and relaxation strength, the authors use the time-temperature relationship for creep and rupture stresses T(C + log t), proposed by Larson and Miller ("A Time-Temperature Relationship for Rupture & Creep Stresses," by F.R. Larson & J. Miller, *Trans. ASME*, Vol 74, No. 5, July 1952). They point out that this relationship yields more reasonable 100,000 hr strength predictions and also permits the use of short-time tests for this purpose. In the paper, the G-E engineers give detailed results in tabular form on rupture strengths for each of the alloys at various temperatures. Fig 2 shows summation curves for these data.





In general, the authors point out that these alloys are less susceptible to stress corrosion than the austenitic type alloys. An accelerated test also showed that the modified 12% chromium alloys resisted stress-corrosion cracking by a factor of 10 to 1 in time over the straight 12% chromium (Type 403) for equivalent hardness and applied stress.

In a brief discussion of surface hardening, an ammonia-gas method of nitriding is said to be most satisfactory in regard to case depth, hardness, and corrosion resistance to steam. At extended high temperatures indications are that hardness will fall from a minimum hardness of 62 Rockwell C for a case thickness of 0.006 to 0.008 in., but that it will probably not fall below 49 Rockwell C after 100,000 hr at 1050 F.

High Temperatures and Pressures Affect Corrosion Resistance of Casting Alloys

With the recent trend in the chemical industry toward higher temperatures and pressures, the need has grown accordingly for research on the corrosion of various metals and alloys at temperatures above the boiling point of the solutions generally used.

In a paper presented before the National Association of Corrosion Engineers in March, 1953, F.H. Beck and M.G. Fontana, discuss some of the results of a project instigated by the Alloys Casting Institute to determine corrosion effects on commercial grades of corrosion resistant casting alloys at elevated temperatures and pressures. The authors studied the effects of nitric, phosphoric, acetic acids and

(Continued on page 170)

sodium hydroxide at temperatures up to 425 F on four low carbon chromium-nickel alloys, cast titanium, and high silicon iron.

Surprisingly high corrosion rates were encountered for the stainless steels in nitric acid at slightly elevated temperatures and pressures. Test results indicated that titanium will resist corrosion at temperatures in excess of the 345 F temperatures used in the studies, and that high silicon iron loses some of its resistance in hot dilute nitric, while it shows appreciable corrosion rates in dilute nitric at temperatures above the boiling point. The authors also point out that improved resistance of the stainless alloys may be gained by the addition of nickel.

The austenitic stainless steels were found to be quite resistant to phosphoric acid in concentrations up to 50% acid by weight and at all temperatures up to and including the boiling point. Above 50% concentration these alloys, in many cases, lose their resistance, particularly when exposed to boiling acids. It appears also that the use of inhibitors in the form of metallic ions may aid greatly in extending the usefulness of the less expensive alloys, though a considerable amount of testing must still be done to gain conclusive data.

The stainless steel cast alloys are quite resistant to acetic acid of all concentrations and temperatures up to the boiling point of the acid, though corrosion rates in glacial acetic acid may vary between a few mils and several hundred mils per year at temperatures only slightly above the boiling point. However, comprehensive data are not complete enough for further discussion.

When exposed to aqueous solutions of sodium hydroxide of all concentrations below 50%, the stainless steels showed resistance at all temperatures up to the boiling point. Tests at temperatures slightly above the boiling point of the acid solutions showed substantial increases in the corrosion rates.

Effect of Cyclic Thermal Stresses on Ductile Metal

In a lengthy paper prepared for The American Society of Mechanical Engineers' annual meeting, Dec., 1953, Louis F. Coffin, Jr. of G-E discusses the results of a study of cyclic strain and fatigue failure caused by cyclic thermal stresses on Type 347 stainless steel.

The author points out that when thermal effects become cyclic in nature the stresses are first elastic, then become plastic for more severe thermal effects. When the thermal load is removed the stresses are first reduced elastically; however, due to the previous plastic action, complete

Contents Noted | continued

thermal unloading will cause the stresses to reverse their direction. If the conditions are severe enough, these stresses can cause a reversal in plastic flow. Thus, if reversed plastic flow occurs with each thermal cycle, eventual damage to the part can occur by fatigue.

The tests conducted confirmed the significance of cyclic plastic strain as the basic cause of fatigue failure in the metal. Strain-hardening of the initially annealed material during strain-cycling was found to be very small and tended to saturate. The amount of strain-hardening increases with increasing strain amplitude, but a saturation again occurs. Thus a fairly stable hysteresis loop is characteristic of the fatigue process.

The author states that prior cold-working results in a strain-softening of the material which depends on the strain amplitude and amount of prior cold work. This cold working also acts to reduce the ductility available for fatigue so that under the same plastic strain amplitude the life of the material is actually less than that of annealed materials.

Reversed plastic strain was found to have little effect on mechanical properties until a fatigue crack occurs. This crack then acts as a stress raiser to decrease the fracture ductility.

A quantity defined as the total plastic strain, which can be calculated for each specimen, is found to increase as the number of cycles-to-failure increase. This relationship can be extrapolated to give a value which agrees with fracture ductility in simple tension. Other conditions being equal, the total plastic strain is reduced by prior cold work.

Proposed Additions to Pressure Piping Standards

In a paper presented at The American Society of Mechanical Engineers' annual meeting, Dec., 1953, Rudolph Michel details the results of an ASA committee's work in revising the Code for Pressure Piping. As well as publishing tables and graphs presenting the committee's findings for various metals, Mr. Michel discusses the factors encountered in the work and the general conclusions at which they arrived.

The author points out that the use of different measuring techniques in determining elastic constants accounts for the greatest spread in the moduli of elasticity of various metals and he discusses various types of testing procedures.

The investigations showed that dynamic methods of determining elastic constants agree closely with static methods for temperatures where creep is negligible; however, above this temperature wide

differences occur between the two methods, and in this case static methods are recommended when making thermal stress computations for hot piping systems. However, the author points out that the method for making static test for moduli at elevated temperatures is not standardized.

The report further recommends standardization in (1) number of test specimens to be used for each temperature, (2) method of bringing the specimens up to temperature (whether loaded or unloaded), (3) range of stress to be covered during the test, and (4) length of time under load.

Comparing High Temperature Properties of British and American Steels

Some substantial differences exist in creep data published in various countries on similar steels. Since these differences directly affect allowable design stresses, The Timken Roller Bearing Co. and The United Steel Co.'s of Britain exchanged specimens of five representative high temperature steels, three ferritic and two austenitic, in order to (1) compare the testing techniques used in the two countries, and (2) determine if creep properties of similar steels show wide variation.

In discussing the result in a paper published in December, 1953 by The Institution of Mechanical Engineers, W.E. Bardgett, B.Sc. of the British concern, and Dr. C.L. Clark of the American, point out that only two British steels, both of ferritic type, showed similar creep behavior compared with the corresponding American steels, while the remaining three austenitic steels showed appreciable differences.

In conducting their tests the same method of heat treatment was used in each country for each corresponding specimen, and one temperature and stress for each material for the duration of the tests, which lasted a minimum of 1,000 hrs.

On the basis of the results it was apparent that due to the similarity in behavior of the ferritic steels, British and American laboratories can check one another in the determination of creep characteristics of this type of material.

The authors attribute the substantial differences in the creep behavior of austenitic steels to the greater sensitivity of these alloys to variations in the heating period prior to testing and in rate of loading. These conditions, it is pointed out, must be closely controlled to obtain reproductibility. Also noted was a difference in grain size and composition which would affect this factor.

They further conclude that on the basis of this limited test, for certain of the

Contents Noted | continued

steels examined, there is no justification for differences in stress specifications in the two countries.

How Reliable Are Long-Range Design Stresses?

In a companion paper to the above, R.W. Bailey, D.Sc., Wh.Sc., F.R.S., questions the validity of British and American laboratory techniques for determining long-range creep stresses for metals used in high temperature power plants.

The author points out that in present testing procedures the influence of thermal action on the metal under stress is not given enough consideration. Due to the limited testing time available, extrapolation procedures must be adopted utilizing data from tests which rarely run for as long as one-tenth, and frequently less than one-hundredth, of the anticipated service time of the metal. With extensions of this magnitude, uncertainties concerning stress values arise, and according to the author, with lack of the proper emphasis on thermal effect, the results become even more unreliable.

In discussing the testing techniques, the author advocates a method whereby the stress is held constant and the test temperature varied to accelerate creep, rather than the more commonly accepted method of making the working temperature the test temperature and varying stress to accelerate creep. By following the former technique, the author states that the influence of thermal action on the metal is given greater consideration and the most dependable stress figures and reliable assessment of materials obtained.

Hardness Testing of Plastics

Though indentation hardness testing has been applied to plastics as well as metals, there is the additional factor of the effect of time on the length or depth of penetration which must be taken into consideration when testing this non-metallic material.

Paul Grodzinski, in an article in the September, 1953 *Plastics* (British), describes two devices recently developed which give sensitive, reproducible results, and still accurately measure the effect of the element of time.

The T.N.O. hardness tester which can be attached to a microscope, uses a small conical condenser, the change in capacity of which measures the size of the indentation. The condenser is made up of two conical shells, an outer and an inner. The latter supports a Vickers diamond pyramid which extends through the end of the outer shell. As the load is applied from above, and the indentor sinks into the specimen, the inner shell lowers and approaches the outer shell of the condenser. This changes the capacity of the con-

denser, and the progressive depth of penetration measured by the resulting change in capacity can be graphed directly from readings on the attached micro-ammeter.

Another instrument described is further equipped with a device for progressively increasing the load during the test, thereby supplying a record of the depth of penetration obtained under various loads.

This device employs a counterbalanced beam which, as a sliding weight is moved across it, exerts an increasing force on the indenter. As the indenter moves into the specimen, a sapphire plate moves away from an air valve. The resulting decrease in air pressure in the line servicing the valve is registered on a diaphragm which, in turn, actuates a stylus, producing a permanent record of load, time, and depth of penetration.

Stress-Rupture in Chromium-Nickel Welds

In a paper presented at the annual meeting of The American Society of Mechanical Engineers in Dec., 1953, R.D. Wylie, C.L. Corey and W.E. Leyda discuss the results of some tests on the high-temperature strength of weld deposits which must be used in joining austentic chromium-nickel steels in superheaters used in power boiler equipment.

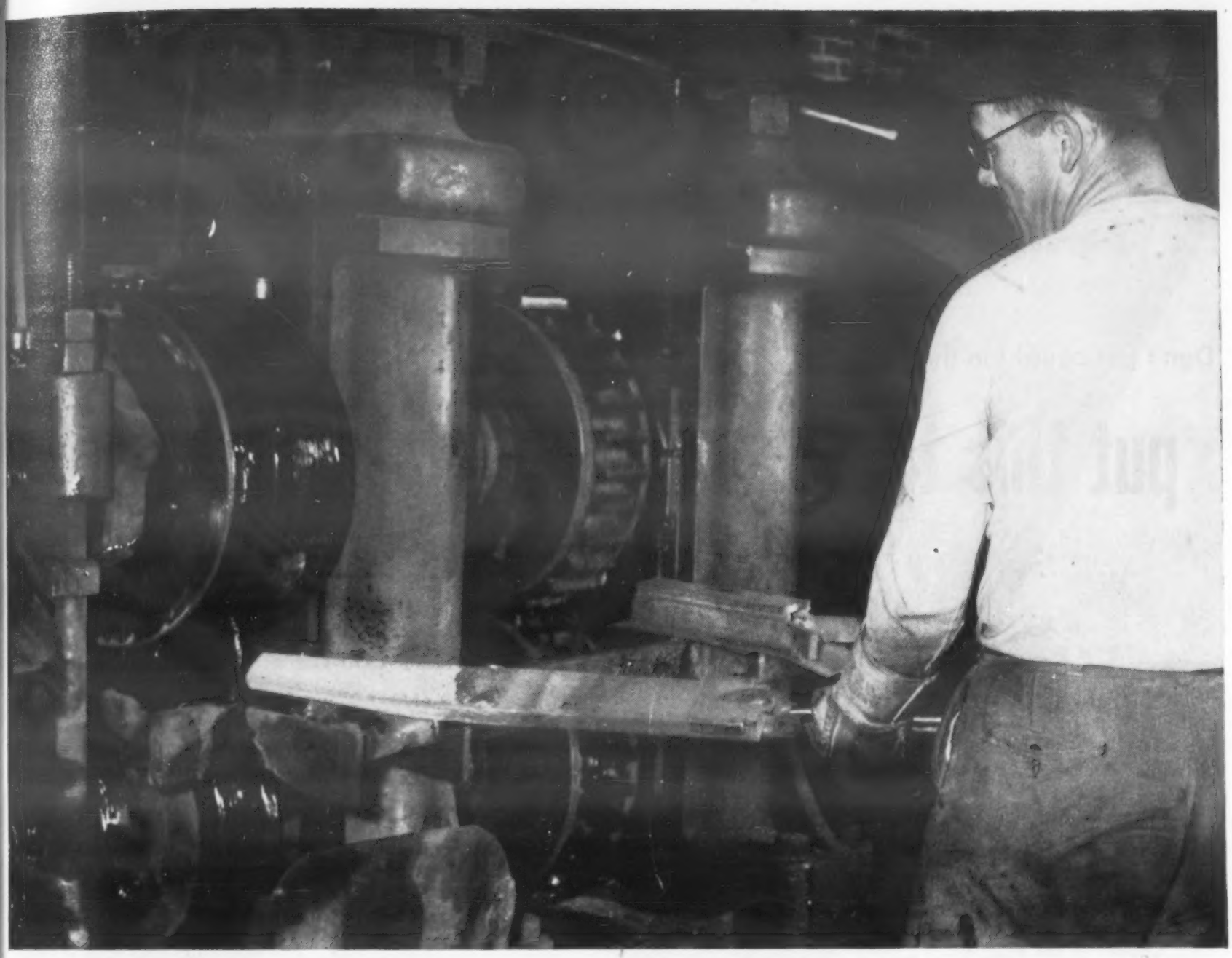
The electrodes used were chromium-nickel alloys of various analyses, some of which were stabilized with columbium. The principal test temperature employed was 1200 F, some of the test running longer than 10,000 hr.

Data on the stainless steel weld deposits tested indicate that weld metals have in general lower rupture strength than wrought materials of corresponding chemical analysis, particularly at temperatures above 1200 F. The authors also point out that deposits stabilized with columbium showed better stress-rupture properties than those which were not.

Austenitic weld deposits exhibit low rupture ductility at elevated temperatures as compared with corresponding wrought materials, though the significance of this with regard to service requirements is not completely clear at this time. However, there seems to be some possibility of improving the rupture ductility particularly in short time tests by chemical and structural modifications of these materials.

The authors emphasize finally that this paper represents the first progress report on an extended program initiated at the Babcock Wilcox Co. to aid in the selection of allowable stresses for the chromium-nickel stainless steels.

(Continued on page 178)



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Fretting Corrosion Studied

A report published by the National Advisory Committee for Aeronautics in Dec., 1953, details the results of several years study of fretting corrosion of metals, by a group at M.I.T. The authors of the report, H.H. Uhlig, I. Ming Feng, W.D. Tierney, and A. McClellan, state that the tests were made on mild steel, fretted against itself, and with consideration given to effects of humidity, temperature, test duration, atmosphere, relative slip, pressure, and frequency.

The ambient humidity was found to be a sensitive variable, the weight loss of mild steel due to fretting at 100% relative humidity being only 55 to 65% of the weight loss at 0% relative humidity. At the same time it was observed that fretting corrosion was appreciably greater below room temperature than above room temperature (up to 300 F).

The results of the investigations suggest that the observed damage from fretting corrosion is due to the sum of mechanical and chemical factors. An asperity, rubbing on a metal surface produces a track of "clean" metal which immediately oxidizes or upon which gas rapidly adsorbs. The next asperity wipes off the oxide or initiates reaction of metal with adsorbed gas to form oxide, and so forth. This constitutes the chemical factor, while the mechanical factor consists of the shearing action of the asperity which removes a portion of the metal.

The metallic debris produced is thought not to oxidize spontaneously, but instead to convert partially to iron oxide by secondary fretting action of particles rubbing against themselves or adjacent surfaces. This accounts for the fact that ferric oxide has been found to be the major corrosion product of this type of action.

By combining the factors determined during the study, an equation is developed which predicts that the fretting-corrosion weight loss of a specimen is a hyperbolic function of frequency, is parabolic with load and is linear with number of cycles or magnitude of slip. In addition, the calculated reaction rate constant for oxidation of a freshly formed iron surface obtained from fretting data is reasonable and falls between two independently observed values.

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Contents Noted

Books

METALLURGICAL DICTIONARY. *J. G. Henderson and J. M. Bates. Reinhold Publishing Corp., New York 36, N. Y., 1953. Cloth., 9 by 6 in. 396 pp. Price $8.50.*

This is a comprehensive, easy-to-use reference book containing over 5000 definitions and descriptions of the most essential terms used in production and physical metallurgy. In addition to standard definitions, it includes a considerable number of original definitions for such terms as flame plating, shell molding and others which have just started to appear in magazine literature. Cross references to related terms direct the user from a synonym to a preferred term and offer him full coverage of available information.

An extended coverage of some of the more common metals and alloys is given in an appendix. Included are discussions of steel, alloy steel, stainless and heat resisting steels, cast iron, aluminum, copper, lead, nickel and zinc.

This book will be an invaluable source of information for metallurgists and engineers in associated fields and will be highly useful to the specification writer and purchasing agent.

PROTECTIVE ATMOSPHERES. *By A. G. Hotchkiss and H. M. Webber. John Wiley & Sons, Inc., New York, N. Y., 1953. Cloth, 9 by 6 in. 341 pp. Price $7.00.*

This book is divided into nine chapters. Tabulated for ready reference in the first are data showing compositions and costs of typical protective-atmosphere gases and a general discussion of applications. The second chapter is concerned with the chemical reactions of the gases used for furnace atmospheres. Following these introductory chapters, succeeding chapters deal with atmospheres for preventing or reducing oxides; for preventing decarburization; and for carburizing, carbon restoration and nitriding. Instrumentation and the storage and handling of gases are covered in subsequent chapters. An extended discussion of applications and remedies for protective atmosphere troubles concludes the book. Each chapter is followed by a list of pertinent references which will prove

valuable in pursuing the subject further.

This book should be a useful handbook for process engineers, plant engineers and metallurgists.

ASME HANDBOOK—METALS ENGINEERING DESIGN. *Edited by Oscar J. Horger. McGraw-Hill Book Co., New York 36, N. Y., 1953. Cloth, 10 by 7½ in. 405 pp. Price $10.00.* Sponsored by the Metals Engineering Handbook Board of the American Society of Mechanical Engineers, the volume brings together important reference data on the design function in metals engineering. Many aids for relating considerations of material selection, design procedure, strength properties, and processing operations for good design are available in one place. Forty-eight sections, contributed by authorities writing on the subjects for which they gained recognition, discuss topics including fatigue characteristics, wear consideration, impact corrosion, non-destructive testing, elasticity and theories of failure.

A BIBLIOGRAPHY OF SELECTED AEC REPORTS OF INTEREST TO INDUSTRY. PART 1—METALLURGY AND CERAMICS. *TID-3050 (pt. 1) Technical Information Service, U. S. Atomic Energy Commission, Washington 25, D. C., 1953. Paper, 10½ by 8 in. 38 pp.* This bibliography consists of 219 selected references which appear to be of interest to industries in the metallurgical and ceramic fields. It is one of a series covering non-classified reports on research and development work sponsored by the AEC.

REPORT ON THE ELEVATED-TEMPERATURE PROPERTIES OF CHROMIUM-MOLYBDENUM STEELS. *American Society for Testing Materials, Philadelphia 3, Penna., 1953. Paper, 8½ by 11 in. 210 pp. Prices: $4.75; to ASTM and ASME Members, $3.50.* This is the second in a current series of reports prepared under the auspices of the Data and Publications Panel of the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals. This report is a graphical summary of the elevated-temperature strength data for the chromium-molybdenum steels. It includes summary curves for tensile strength; 0.2% offset yield strength; percent elongation and reduction of area; stresses for rupture in 100, 1000, 10,000 and 100,000 hr; and stresses for creep rates of 0.0001 and 0.00001% per hr (1% in 10,000 and 100,000 hr).

SYMPOSIUM ON NON-DESTRUCTIVE TESTING. *American Society for Testing Materials, Philadelphia 3, Penna., 1953. Paper, 6 by 9 in. 104 pp. Price: $2.00; to ASTM Members, $1.50.* A group of eight papers by international authorities in their respective fields presented at the 50th Anniversary Meeting of the ASTM in 1952, are included here. Although it discusses principally the testing of metal: sheets, rods, castings, forgings, machined assemblies, and the like (plastics are mentioned), the symposium provides excellent data and ideas for those interested

Contents Noted

Books continued

in non-destructive testing of other materials. The text is illustrated with photographs of equipment, manipulative techniques, and oscilloscope patterns when applicable, and also diagrams and charts.

SYMPOSIUM ON PORCELAIN ENAMELS AND CERAMIC COATINGS AS ENGINEERING MATERIALS. *American Society for Testing Materials, Philadelphia 3, Penna., 1953. Paper, 6 by 9 in. 141 pp. Price: $2.50; to ASTM Members, $1.85.* This symposium was organized by the ASTM Committee C-22 on Porcelain Enamel as a carefully planned and thorough effort to make "working engineers" better acquainted with the very useful and available subject materials. In the program due attention was given to a number of important, but diversified fields to which such coatings are particularly adapted. These fields cover areas wherein an attractive and easily maintained surface is desired or where metal is subject to deterioration by such things as heat, abrasion, vibration, or close contact with corrosive liquids and gases of many kinds.

Reports

INVESTIGATION OF INFILTRATED AND SINTERED TITANIUM CARBIDE. *Sintercast Corp. of America, Yonkers, N. Y. On Contract No. AF33(038)-16103. Order separate parts described below from Library of Congress, Publication Board Project, Wash. 25, D. C.*

PROGRESS REPORT NO. 5. PRODUCTION OF TITANIUM CARBIDE. *John B. Adamec, 1951. PB 109767, 26 pp. Microfilm $2.00, photostat $3.75*

FINAL AND SUMMARY REPORT, 1952. *PB 109766, 59 pp. Microfilm $2.75, photostat $7.50.* Among materials tested, titanium carbide-Inconel, infiltrated by the capillary infiltration method, had the most favorable combination of high temperature strength, ductility and oxidation resistance at elevated temperatures.

LIQUID PHASE SINTERING. *Final Report Under Contract No. AF33(038)-11865. F. V. Lenel and H. S. Cannon. Rensselaer Polytechnic Institute. Powder Metallurgy Laboratory, Troy, N. Y., 1951. PB 110-475, 63 pp. Library of Congress, Publication Board Project, Wash. 25, D. C. Microfilm $3.00, photostat $8.75.*

STRUCTURAL EFFICIENCIES OF VARIOUS ALUMINUM, TITANIUM AND STEEL ALLOYS AT ELEVATED TEMPERATURES. *George J. Heimerl and Philip J. Hughes, U. S. National Advisory Committee for Aeronautics, 1953. 16 pp. Available from National Advisory Committee for Aeronautics, 1724 F. St., Wash. 25, D. C.*

BEHAVIOR OF MATERIALS UNDER CONDITIONS OF THERMAL STRESS. *S. S. Manson, U. S. National Advisory for Aeronautics, 1953. 105 pp. Available from National Advisory Committee for Aeronautics, 1724 F St., Wash. 25, D. C.*

CORNING GLASS BULLETIN

FOR PRODUCT DESIGNERS

HOW the most remarkable glass in 4000 years was invented . . . Modern kitchen ranges are full of ideas . . . Do you know how glass conducts electricity?

People are always looking for something new and better. You spend most of your time seeing that they get it.

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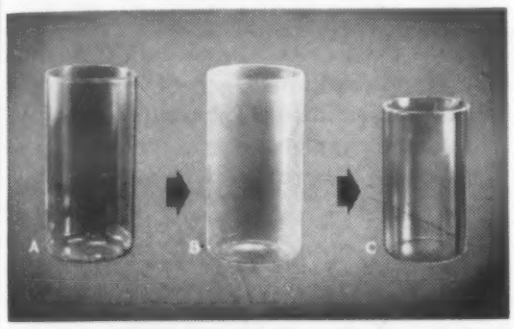
Hence this Bulletin, the first of a series which will talk briefly about new and unusual glasses—in the hope that you will let us send you more complete information. For your convenience, there's a coupon below.

most remarkable glass

In 1952 Philadelphia's Franklin Institute presented the John Price Wetherill Medal to Corning's Dr. Martin E. Nordberg and Harrison P. Hood for inventing the most fabulous of glasses—VYCOR brand 96 per cent silica glasses.



Evolution of a VYCOR jar: A—formed by conventional glass blowing; B—"thirsty glass"; C—finished product.

These two scientists discovered a composition that appeared to be a combination of two distinct types of glasses. One type could be dissolved out, leaving a skeleton of 96 per cent or more of silica filled with so many millions of holes that a one-inch cube contained some 60,000 square feet of hole surface.

This new child of research was dubbed "thirsty glass" because, just sitting around, it absorbed moisture right out of the air. But our researchers were on the trail of something even more exciting. They heated their "thirsty glass" and it shrank to two-thirds its original size. The millions of little holes vanished and left a vacuum-tight glass that looked like any other—except that you could take this new glass white-hot from a blazing furnace and plunge it into ice water without the slightest injury. It was a glass as ideal as fused quartz, but different since it could be melted, mass produced, and worked in its original state like ordinary glass.

The newest use for VYCOR brand 96 per cent silica glasses is in Sylvania's instant-heat lamp for electric ranges. *We'll tell you more in later bulletins about other uses these glasses have already found. If you'd like to know more NOW, just check the coupon below.*

ideas

Today's smart gas and electric ranges have wrought a kitchen revolution. And glass has made its contribution—design-wise and utility-wise.

Some of the newest ranges include several kinds of glass items. PYREX brand oven door panels that let you see what's cooking; broiler plates, door handles, broiler shields, oven roundels to protect non-heat-resistant lamps. *Opal* glasses for decorative stove-top lighting. *Multiform* glass beads for electric surface units. Top-of-stove burner protection units made of VYCOR brand 96 per cent silica glass. Attractive designs and name plates permanently captured in *photosensitive glass* panels. (Photolay, we call this application. It gives a 3-D effect to anything that can be reproduced photographically.)

Sears-Roebuck's new Kenmore range with a Sylvania instant-heat lamp unit which has a VYCOR bulb and tinted cover plate.

Wonder if there might be an idea or two for you in what the modern stove designer is doing with glass? We'd be glad to tell you more.

conducting electricity

One of the interesting exhibits at the Corning Glass Center shows an electric light bulb mounted in the middle of what looks like an ordinary plate glass window pane. But push a little doorbell button beneath the pane and behold—the electric bulb lights up. The window pane isn't a window pane at all. It's a glass that conducts electricity—E-C (*E*lectrically *C*onducting) glass.

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Flick a switch and this electric bulb mounted on a glass panel lights up. Magic? No—this glass conducts electricity.

If the items listed below don't seem to bear on your problem, we may have what you need at our fingertips. We'd like to hear from you.

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news of ENGINEERS COMPANIES SOCIETIES

News of Engineers

George O. Bohrer has been named chief engineer of Magnesium Co. of America. Mr. Bohrer, who for the last three years has been an assistant plant manager of Continental Can Co., succeeds the late V. J. Daniels.

Harry A. Winne recently retired as vice president of General Electric Co. after more than 43 years of service. He was presented the 1953 James H. McGraw Award for electrical men at a luncheon of the 27th annual session of the National Electrical Manufacturers Assn.

Manley E. Lord, manager of General Electric Co.'s Fractional Horsepower Motor Dept. retired after 45 years of service with the company.

H. E. Mahan, manager of the General Electric Illuminating Laboratory and an international authority on outdoor lighting, has retired after more than 43 years with the company.

H. Sturgis Potter, Arlington A. Britton, Jr., and **John Moxon,** three executives of Carpenter Steel Co., have recently been elected vice presidents of the company.

J. L. Holmquist, director of research, Spang-Chalfant Div., National Supply Co., was honored by the Association of Iron and Steel Engineers with the Kelly Award in recognition of his paper describing an "Investigation of the Displacement of Material in the Mannesmann Piercing Process by Means of Model Wax Billets."

Paul J. Selinger, former assistant chief, Tube Section, Iron and Steel Div., National Production Authority, has been appointed manager of stainless tubing sales. Standard Tube Co.

Charles M. Ruprecht, formerly vice president of the Electro-Alloys Div., American Brake Shoe Co., has been appointed president of that division.

Edward Van der Pyl, director of equipment engineering at Norton Co., has retired after 44 years with the company. Mr. Van der Pyl has been responsible for 45 patents, most of them in the field of diamond grinding wheels.

John T. Richards, formerly with the Beryllium Corp., was recently named president and chief engineer of Penn Precision Products, Inc.

Joseph P. Stanavage has joined the Research and Development Div., Pennsylvania Salt Manufacturing Co., and will work on projects of the Corrosion Engineering Products Dept.

news of | SOCIETIES

Alex Stewart has been named vice president, director and general manager of National Lead Co. of Ohio. He will continue as director of research for National Lead Co.

Edward L. Bohn has been made vice president of Mullite Refractories Co.

Fred B. Shaw has been appointed director of Conolite research, Continental Can Co.

G. C. Hollingshead has been appointed production engineering manager at Air Associates' Aircraft Products Div.

Robert R. Walters and **Elizabeth Bergenn** have joined the research staff of Bjorksten Research Laboratories.

Alton W. Bardeen, formerly chief metallurgist of the Ohio Brass Co., succeeds the late R. W. Parsons as technical director of the company's Mansfield plant.

Julius F. Sachse, formerly vice president and works manager of Metals Disintegrating Co.'s Elizabeth plant, has been appointed vice president in charge of research and development for the company.

Richard G. Tessendorf has been elected a vice president of Aluminum Industries, Inc.

Gordon P. K. Chu and **George Warren,** ceramic engineers, have joined the research staff of the Pfaudler Co. Both men will work on the chemical and physical properties of glass-steel.

Harry C. Millerburg has been elected president of Loven Chemical Co. to succeed the late Dr. Karl A. Loven.

Dr. Howard E. Fritz, vice president in charge of research, B. F. Goodrich Co., has announced his retirement as of Jan. 1, 1954.

George D. Hooper, formerly chief engineer and plant manager, National Machine & Tool Co., has joined Carboloy Dept., General Electric Co. as a development engineer in the magnet materials and process development unit.

Dr. Byron F. Murphy has been appointed leader of the physics section central research dept., Minnesota Mining & Manufacturing Co.

Joseph J. Constantino has joined Hooker Electronchemical Co. as a design engineer.

Dr. George A. Roberts has been elected to the post of vice president in charge of technology, Vanadium-Alloys Steel Co. Dr. Roberts was formerly chief metallurgist for the company.

Dr. John C. Hamaker, Jr. has joined Vanadium-Alloys Steel Co.'s Metallurgical Research Dept.

Dr. Raymond M. Fuoss has been employed as a consultant by U. S. Testing Co. Dr. Fuoss will be responsible for research activities in the company's Boston

How Ductile Iron Cut Costs:

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Profit from the example of Metal Products Division of Koppers Company, Inc., Baltimore 3, Md. This manufacturer not only cut costs but improved performance of one of their specialties by adopting Ductile Iron hubs for "Aeromaster" industrial fans.

These propeller-type fans, ranging from 54 inches to 24 feet in diameter, are generally used in pipeline pumping stations and similar places where vibrations from nearby engines, compressors or other machinery compound the vibrations of a fan.

INCO

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news of ENGINEERS

labs., and will also coordinate work done between Boston and the main laboratories.

A. G. Bissell, for 17 years head civilian of the Welding, Casting and Forging Branch, Bureau of Ships, U. S. Navy and recently retired, has been appointed a consultant for Metal & Thermit Corp.

Dr. G. Carl Vogelsang has been appointed technical director, Gates Engineering Co.

J. T. O'Brien has been named vice president-operations, Firth Sterling, Inc.

O. E. Anderson has been appointed to the technical staff of Continental-Diamond Fibre Co.

H. K. Phinney has been named manager, Laminating Materials Div., Bakelite Co.

John H. Lamothe has been elected vice president and general manager of the Wheeler Reflector Co. At the same time **Fulton A. Eldridge** was named vice president in charge of production.

Philip M. McKenna, president, Kennametal Inc., has been named to receive the Holley Medal awarded by the American Society of Mechanical Engineers at its annual meeting in New York.

Howard J. Davis has been appointed to head Colorado Fuel and Iron Corp.'s new department to coordinate and expand product research and development. The new organization will have its headquarters in Washington, D. C.

Ellsworth M. Smith, formerly chief metallurgist of The Beryllium Corp., has been named vice president and chief metallurgist of Penn Precision Products, Inc.

Died.....Harold B. Thomas, a founder of the Elastic Stop Nut Corp. of America and product analysis consultant.

.....**James H. King,** vice president and director, Babcock & Wilcox Co.

News of Companies

Watson-Stillman Division, H. K. Porter Co., Inc., has announced a $250,000 expansion program. This will include additional land, buildings and the installation of specially designed automatic machine tools for increased production of forged steel fittings.

Metal Carbides Corp. is constructing a new 40,000 sq. ft. plant on a 25-acre site at 6001 Southern Blvd., Youngstown. The plant is expected to be in operation this month and will be used to produce tungsten carbide metal including tool tips, die nibs, bar stock, rings, bushings and special shapes.

(Continued on page 192)

news of | COMPANIES

The Allis-Chalmers Manufacturing Co. has assumed operation of the **Buda Co.** The new addition will be operated as the Buda Co., a division of Allis-Chalmers.

Monsanto Chemical Co.'s Plastics Div. has announced a $1,250,000 technical service and development program that will include a new research center for customers and industry in the plastics field.

Airex Rubber Co. has just completed an addition to its building which will double its present facilities. The new section will also house part of the company's expanded rubber-to-metal bonding and subassembly departments and additional laboratory facilities.

Durez Plastics & Chemicals, Inc. has announced construction of a new plant for the manufacture of Durez phenolic molding compounds at a recently acquired site in Kenton, Ohio.

Barium Steel Corp. has established three graduate fellowships for advanced studies in engineering. Grants for one year graduate fellowships will be made annually to Massachusetts Institute of Technology in mechanical engineering; the University of Pennsylvania in metallurgy; and Case Institute of Technology in electrical engineering.

Borden Co.'s Chemical Div. has acquired American Polymer Corp. The move is in line with the division's policy of expansion in the field of basic chemicals.

Koppers Co. has purchased the business of **American Ore Reclamation Co.** For many years a leader in the design and engineering of sintering machines and sintering plants, American Ore Reclamation Co. has been credited with many outstanding contributions to the technology of iron ore agglomeration.

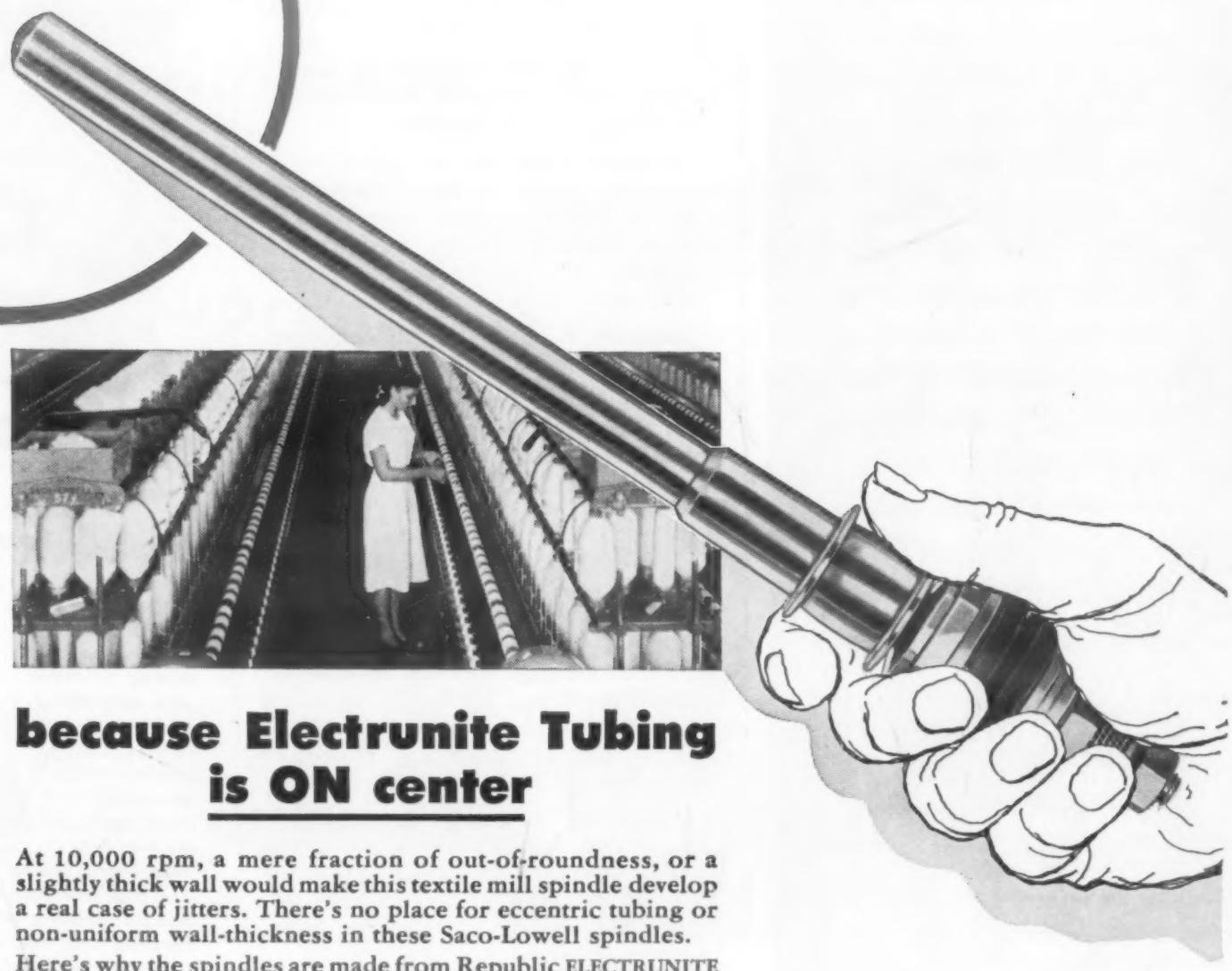
Bendix Aviation Corp. has begun construction of a new engineering building to accommodate expansion of its Pacific Div.'s airborne and hydraulic engineering departments.

Roll Formed Products Co. has recently aded 24,000 sq ft of floor space to its plant. The addition houses new, automatic polishing, complete degreasing facilities, and new bending equipment.

Firth Sterling Inc. and Brazilian industrialist, Prof. Ary Torres, completed arrangements which look forward to the immediate formation of a Brazilian company in San Paulo which is designed to become a counterpart of Firth Sterling in Brazil. Operations of the new company are scheduled to begin this month and in the early stages, the new company will import into Brazil the products of Firth Sterling. These will be more than offset by Firth Sterling's purchases in Brazil (raw materials) so that a favorable balance of trade will result.

(Continued on page 194)

10,000 smooth RPM on 25% less power . . .



because Electrunite Tubing is ON center

At 10,000 rpm, a mere fraction of out-of-roundness, or a slightly thick wall would make this textile mill spindle develop a real case of jitters. There's no place for eccentric tubing or non-uniform wall-thickness in these Saco-Lowell spindles.

Here's why the spindles are made from Republic ELECTRUNITE Steel Tubing . . .

Uniform wall thickness and concentricity are assured by the way ELECTRUNITE Steel Tubing is made. The carefully rolled flat steel is inspected on both sides. Then it's formed on precision rolls into a cylindrical shape that's electric resistance welded to make a uniformly strong tube.

The tubes are uniform in every dimension, every contour. They can be fabricated uniformly to produce these spindles that must turn at 10,000 rpm.

One thing more . . . uniformity and concentricity contributed greatly to the development of ball-bearing spindles that cut textile mill power bills as much as 25%.

Probably you have products that would be better or cheaper or longer lasting if you made them from Republic ELECTRUNITE Steel Tubing. We'd like to help you investigate the possibilities.

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Republic
REPUBLIC STEEL
ELECTRUNITE TUBING

For more information, turn to Reader Service Card, Circle No. 426

news of | COMPANIES

Young Testing Machine Co. has opened a new plant for the manufacture of small precision elements. The plant is located in Bridgeport, Penna.

Goshen Rubber Co. has announced construction of a new plant for the fabrication of precision silicone parts.

Superior Tube Co. has purchased a controlling interest in **Fine Tubes, Ltd.,** Surbiton, Surrey, England. Fine Tubes is one of England's largest producers of seamless nickel cathodes and other electronic parts.

Superior Tube Co. recently held open house for its newly completed plant.

Formation of **Ferro Powdered Metals, Inc.,** Salem, Ind., a new wholly-owned subsidiary of **Ferro Corp.** has been announced.

News of Societies

The Magnesium Association, at its 9th annual meeting, unanimously reelected as its president, J. S. Kirkpatrick, vice president, research and development, Brooks & Perkins, Inc. L. G. White, Dominion Magnesium Ltd., was named vice president.

Aluminum Research Institute announced that the name of the association has been changed to **Aluminum Smelters Research Institute.** The purpose of the change is to more clearly indicate the scope of the orginization.

The National Electrical Manufacturers Association has elected as its 24th president, J. H. Jewell, vice president, Westinghouse Electric Corp.

The University of Pittsburgh has let contracts totalling $1,195,000 for the construction of a building to be a new headquarters for its schools of engineering and mines.

Stanford Research Institute has acquired the facilities of the Microwave Engineering Co. of Los Angeles. Steps have been taken to integrate the new facility as a part of its Engineering Div.'s Radio Systems Lab.

National Research Corp.'s Scientific Trust has recently made a grant in the amount of $3,200.00 for the support of scientific research to Massachusetts Institute of Technology, Professor Thomas K. Sherwood, Professor of Chemical Engineering, for studies in the problem of Evaporation at Low Pressures.

The National Metal Trades Association at its 54th annual meeting elected Earle S. Day, vice president and general manager and a director of Collyer Insulated Wire Co., as its president. Also elected to office was Walter F. Newhouse, vice president and general manager and a director of Saranac Machine Co., as vice president.

eliminate the guesswork in selecting tool steels

Thousands of metal working people are using the Crucible Tool Steel Selector to determine exactly which type of steel they need. This handy selector covers 22 tool steels which fit 98% of all tool steel applications.

The selector is unique because it starts with the ultimate use of the steel. It breaks down all tool steel applications into six major classifications, under which the different grades of steel available for certain specific requirements are indicated in legible cutouts. Heat treatment and machinability data are also included for each grade.

A flip of the dial will give you the answer, and almost just as quickly you can get the steel you select. For each type of steel shown on the selector is in stock in Crucible warehouses, conveniently located throughout the country.

To get your Selector merely fill in the coupon and mail. There is no obligation whatsoever.

⅓ actual size, Selector is in 3 colors

HERE'S AN EXAMPLE:

Application — Deep drawing die for steel

Major Class — Metal Forming — Cold

Sub-Group — Special Purpose

Tool Characteristics — Wear Resistance

Tool Steel — Airdi 150

A turn of the dial does it! And you're sure you're right

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Company_____ Title_____

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TOOL STEELS

CRUCIBLE STEEL COMPANY OF AMERICA · TOOL STEEL SALES · SYRACUSE, N. Y.

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News Digest

More Titanium in Aircraft . . .

continued from page 7

strength characteristics of titanium and some may not be reconvertible to more conventional materials. Even current production of military aircraft may run into a brick wall if titanium production isn't increased almost immediately. From testimony about this year's needs it is hard to conceive where the metal is going to come from.

Item: Pratt and Whitney estimates that J-57 jet engines will require a total of 9000 tons in 1954 in order to meet scheduled production orders. This titanium requirement alone is about 2/3 of the most optimistic production total.

Item: Curtis Wright Corp. estimates that it could (and would, if possible) use titanium components at the rate of 36,000 tons a year by 1956. Considering waste and scrap, this would require a basic amount of sponge in excess of 100,000 tons.

Item: Republic Aviation has designs now approaching the production stage which will require large amounts of titanium in "essential" applications.

Item: Douglas Aircraft is now using up to 3% of aircraft weight in titanium, plans to increase the proportion to 20% in two or three years.

While these examples include only a fraction of the total jet and airframe production, they alone account for many times the total amount of titanium that is now produced, and considerably more than the most optimistic estimates of titanium production in the near future.

The reason for the enthusiasm for titanium on the part of aircraft producers is largely the excellent strength weight ratio of the metal. Weight savings in a jet engine, for instance, are compounded by resultant weight savings in lighter engine supports, and weight savings continue to compound in increasing the performance potential of the aircraft. For instance, Douglas Aircraft President Donald W. Douglas reported to the Senate Committee that the use of 528 lb of titanium per plane resulted in a weight saving of 200 lb.

The commercial aircraft industry is generally willing to pay a premium of $20 to $40 a pound for reduced weight and increased payload. The value of weight savings

Case History MM-108

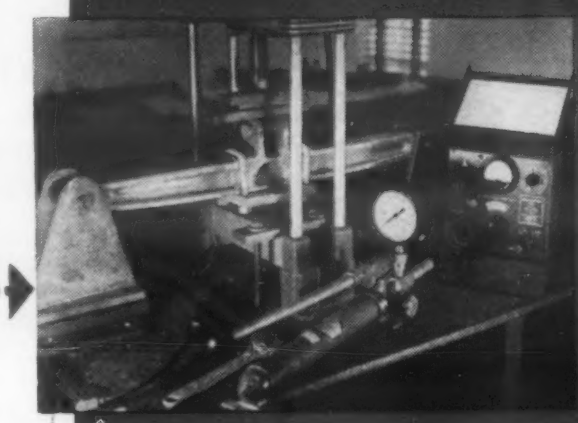
Here's what we mean by *SUPERIOR* ENGINEERED FOUNDRY PRODUCTS...

PROBLEM:

1. This 55-pound cast steel rear spring lock out beam was failing in service.
2. Because the design was not compatible with good foundry practice, it was impossible to consistently produce quality castings.
   (a) An excessive number of feeding risers was required to eliminate a shrinkage condition at the heavy rib junctions.
   (b) The long, deep, narrow pockets were the cause of sand being washed off and becoming trapped in the metal as the casting was being poured.

SOLUTION:

Stress analysis of the original design, in Superior's own stress analysis laboratory, revealed the stresses to be too high and the ribs to be stress risers. Therefore, the design must be modified in order to carry the service loads.



RESULT:

1. Superior's Engineered Foundry Design reduced the critical stress 57.5%, eliminating service failures. Strength was increased 235%, weight reduced 3.2 pounds.
2. The redesign is compatible with good foundry practice and enables the foundry to consistently produce castings that meet the high standards required.
   (a) Elimination of the heavy rib junctions reduces the number of feeding risers required to produce sound castings.
   (b) Trapping of sand in the metal during pouring is prevented because the deep pockets have been reduced.

IT PAYS TO PAY ATTENTION TO CASTING DESIGN

YOU, TOO, CAN BENEFIT BY CONSULTING SUPERIOR'S PRODUCT DEVELOPMENT SERVICE.

If it can be cast, Superior's service developes the best design in which to cast it. If it shouldn't be cast, Superior's service develops the reasons why.

Make your parts Superior Engineered Foundry Products ... castings to 30,000 pounds ... iron, cast... to 200...

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News Digest

in high performance military aircraft is more or less an academic question, since it may be a question of basic air superiority. At any rate, the basic savings that have already been proved by the use of titanium are more than enough proof for the designers of aircraft. They are designing power plants and airframes around titanium that cannot presently be produced using more common metals and alloys.

A more serious aspect of the titanium situation arises when the consequences of an all out war effort are taken into consideration. With present titanium capacity, our best present production aircraft could not be produced in sufficient number to supply wartime needs. Substitution of other materials would necessitate redesign that in some instances would be so extensive that tremendous lead times would be necessary and the performance characteristics of the aircraft threatened. Production of missiles and new aircraft designed around the characteristics of titanium would be out of the question.

The dilemma facing aircraft design, manufacture and procurement is a serious one. Without guaranteed supplies of titanium, the best new designs would be useless in time of emergency. Perhaps even more dangerous than that, if current production and design is set up to use available titanium at present low aircraft production rates there will be no production facilities available for volume production of substitute aircraft and components to meet emergency needs. On the other hand, if aircraft design goes on without titanium, or even with the minimum amount, the performance superiority of our military aircraft is seriously threatened.

The solution, of course, is more titanium. Opinions on how it should be produced reveal another dilemma. Present production methods for Kroll process sponge and consumable electrode or tungsten arc melting are terribly expensive. Quality of alloys is hard to control due to segregation during the build up of the ingot. Pointing out the need for titanium at any cost, one body of opinion in government and industry advocates a vast increase in the present types of production facilities. Others, such as du Pont's Dr. E. A. Gee, counsel a more temperate course. Dr. Gee testified that present

News Digest

production methods show little promise of economy in the long range view, and that current efforts should be devoted to developing a practical and economic method for producing titanium by cheaper, more controllable methods.

What will eventually happen depends on many variables . . . not the least of which is the government's opinion of how badly we need weapons. The eventual course will probably be to get into titanium production as fast as possible on a calculated risk basis, with government guarantees for expensive production facilities which may eventually be junked in favor of new methods that are better and cheaper.

DMS Changes System Reduces Paperwork

Effective this month, the Defense Materials System for allotting steel, copper and aluminum will be simplified. The proposed changes will eliminate a large part of the paper work and record keeping now involved in the production of equipment for military and atomic use.

The major change in the system is to discontinue quarterly allotments of metal supplies to subcontractors working on military contracts. As a substitute for the allotments, a simple priority rating will enable the subcontractors to purchase materials directly. Under the DMS, which is actually set up as a strong government controls system that can be quickly adapted to situations of national emergency and material shortage, small subcontractors are required to keep up a complicated and expensive system of bookkeeping. Under the new system subcontractors will simply attach a priority rating to their orders.

Prime contractors will continue to get their metals in quarterly allotments, but they no longer will have to handle the metal used by their subcontractors. Under the 100% allotment system, prime contractors must pass back the metal used by their suppliers from their own quarterly allotments, a situation compounding the amount of paper work.

Aluminum, copper and steel producers will continue to get quarterly directives from the DMS which will require them to reserve a proportion of their production for military and

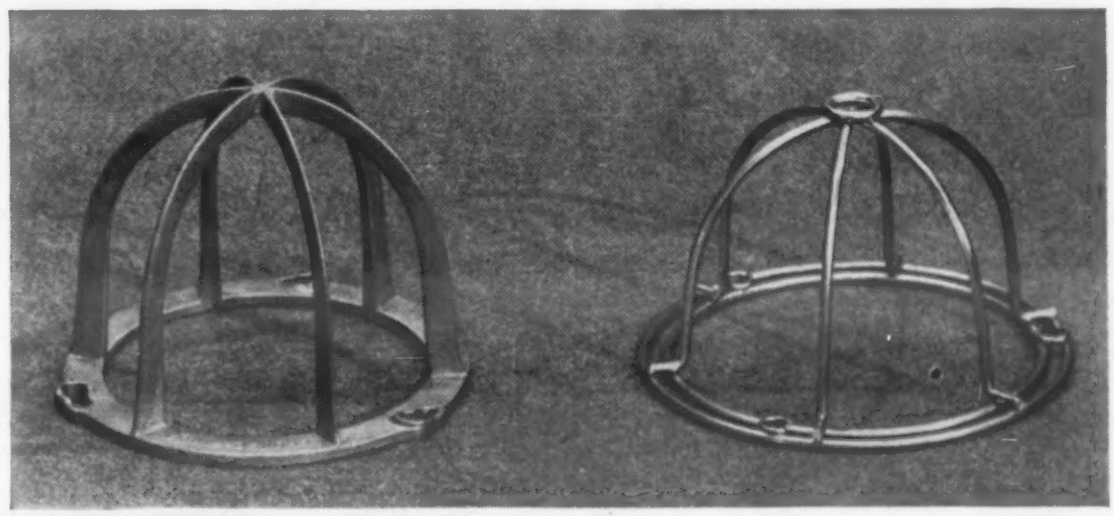
BETTER PRODUCT DESIGN WITH STEEL WIRE

LEGS FOR FOLDING TABLE – Attractively finished in black to resemble wrought iron, steel wire is welded to achieve a stronger, less costly construction than wooden legs. Steel wire is adaptable to a great variety of finishes.

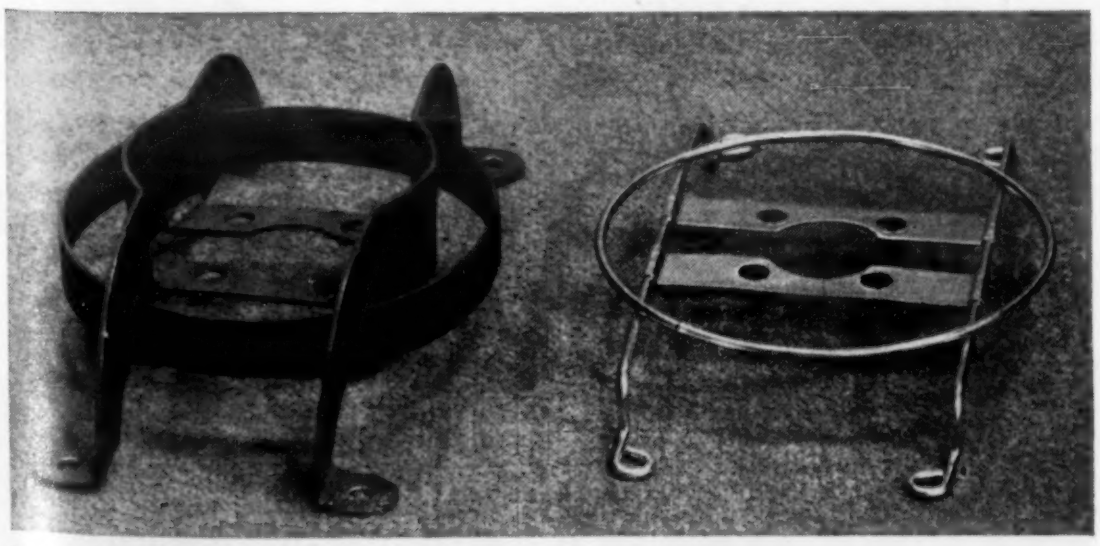
Steel wire can often solve a tricky problem in product design. Besides its eye appeal and great strength, steel wire often makes possible real savings, too. It's readily available and easy to fabricate.

In our modern wire mills we're turning out all kinds of steel wire – for cold-headed items, welded products, springs, gadgets, hardware, fasteners. Some are ordinary grades of wire; others are "specials."

Perhaps you have a design problem to which steel wire would furnish the solution. Let us help you select the grade that combines the strength, ductility and finish that the job requires. Phone or write the nearest Bethlehem sales office for complete information.



LIGHT GUARDS – The improved welded-wire design, at right, uses two concentric rings as a base, spaced to accommodate mounting bolts. Made from economical steel wire, the guard is stronger and less costly than the casting at left.



MOTOR MOUNT – Using spot-welded wire, the redesigned unit at right weighs only 12 per cent as much as the previous design at left. The use of steel wire greatly reduces the cost – and appearance is improved.

Photographs reproduced through the courtesy of E. H. Titchener & Co., Binghamton, N. Y., long a user of Bethlehem Wire. This firm specializes in the imaginative use of wire to simplify product designs and reduce production costs.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor*: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

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News Digest

atomic requirements. The amount to be set aside will include both the metal allotted directly to prime contractors and the amount of metal estimated to meet needs of subcontractors.

Supply Up, Prices Cut On Polyethelene

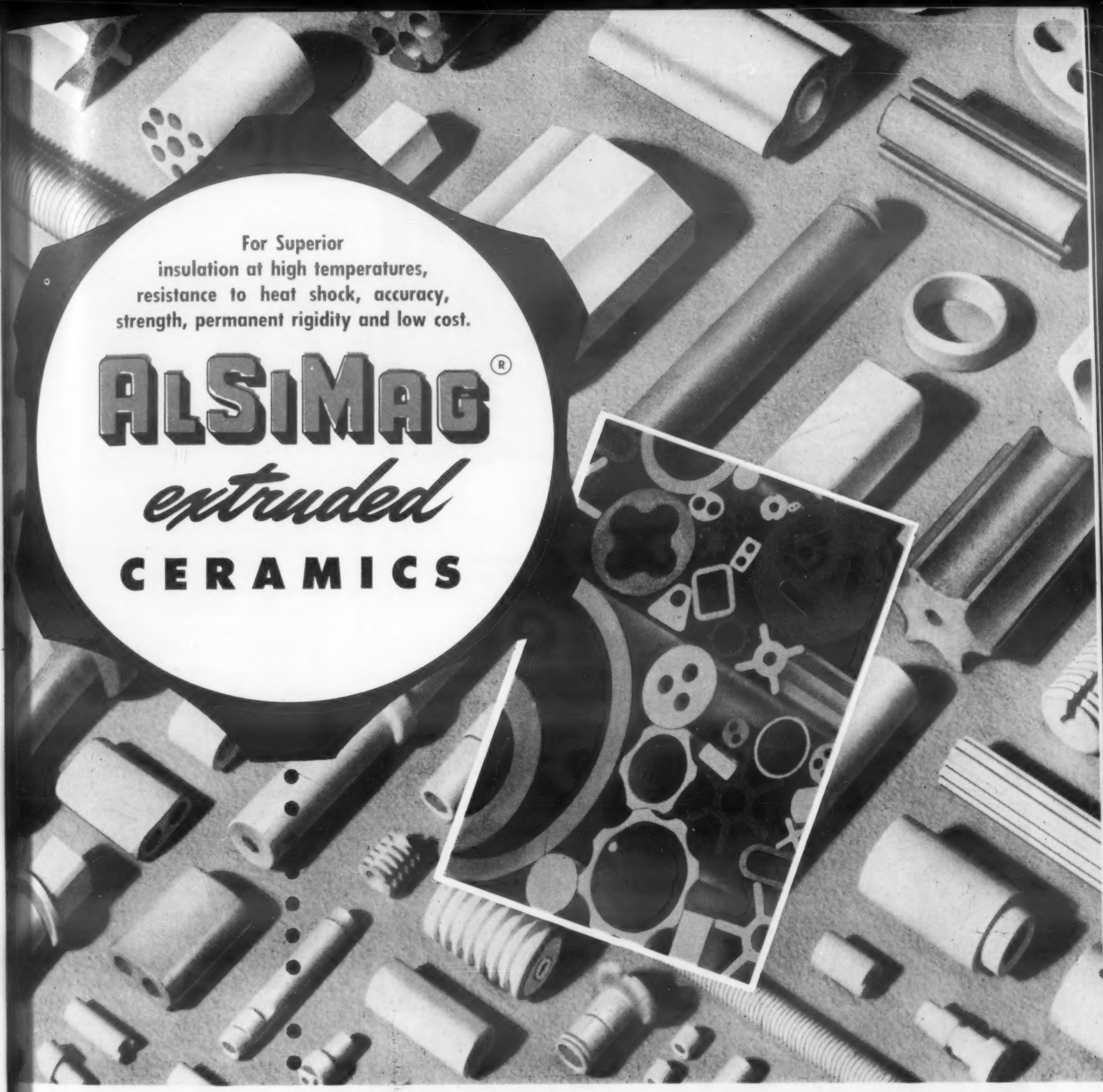
Increased production and lower prices for polyethelene, the tough "squeeze bottle" plastic, are in the wind for 1954.

Polyethelene, a versatile molding material, has been in perennially short supply since its introduction ten years ago. The plastic meets the requirements for a wide variety of applications, such as thin films for food and other types of packaging, pipes for water supply, wire and cable insulation, chemical storage carboys, acid and solvent resistant tank and pipe linings, and many molded household products including the ubiquitous squeezable bottle.

Recently, Bakelite Co. announced its third polyethelene price reduction in less than a year, dropping the basic cost for the material to 41¢ a pound. C. W. Blount, Vice President of Sales for Bakelite called attention to the fact that "Ten years ago, when polyethelene was first introduced, the price was one dollar a pound. We have already reduced the price by 59%. Along with increased production of polyethelene, we predicted a downward price trend." The first of Bakelite's new plants was scheduled to start production last month, and the second will come in early this year. The combined annual production of these two new plants will total about 120 million pounds, or about 85% of the total industry output in 1953.

As if to underline Bakelite's announcement of greater supply and lower prices, Monsanto Chemical Co. announced its entry into the polyethelene field. Monsanto's entry will bring to three the number of primary producers of the material. Monsanto has broken ground for the construction of a plant in Texas City, Texas, which will have annual production capacity of 66 million pounds of polyethelene. Adding Monsanto's facilities to those of du Pont and Bakelite, total U. S. industrial capacity for polyethelene will be about 335 million tons per year by the end of 1954.

(Continued on page 206)



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resistance to heat shock, accuracy,
strength, permanent rigidity and low cost.

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If you will give us details of your requirements our engineers will be glad to submit suggestions without cost or obligation. Try AlSiMag ceramics for best results at low cost.

AlSiMag ceramics can be extruded in uniform cross sections in almost any design. These extruded sections can then be sawed and economically machined before firing. This is the fastest and best way to produce many shapes which seem complex but which are actually quite practical and economical . . . AlSiMag ceramics are not affected by normal operating temperatures of electrical appliances and do not rust, corrode or carbonize. They are uniform physically and dimensionally, are totally and permanently rigid and do not deteriorate with time.

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News Digest

Ramie . . . .

continued from page 8

Its qualities of durability and crush- and abrasion-resistance are outstanding.

History

Ramie is by no means a new discovery. Indeed, its history is actually lost in antiquity. Ramie cloth is probably almost as old as weaving itself. It has been found in Egyptian tombs dating back long before western civilization. Ramie's name stems from the Malay word for the plant, which along with ramie fabric, is fairly common throughout southern Asia and Indonesia where hand labor is used to "degum" the fibers. The plant and fiber were once common in this country, but the expense of hand labor eliminated the product commercially soon after the development of the cotton gin.

The recent renewal of interest of ramie occurred largely as a result of improved chemical and mechanical degumming processes for freeing the fiber from the resins. Much of the progress in chemical degumming was made in France, where the fiber is more commonly used than in this country. French tropical army uniforms are now made of ramie cloth.

Current Uses

Because of ramie's great crush and abrasion resistance combined with its freedom from rot, it is frequently used for bearing packing in ship propeller shaft bearings. It makes excellent hawsers, as it is about three times as strong as hemp, but high costs have limited production.

One of the few current U. S. users of ramie fiber, the Collins and Aikman Corp., produces a 50-50 blend of ramie and nylon for floor carpeting in the new Cadillac automobile. C&A hopes to develop some rugged ramie blends for upholstery fabrics, and they see some promising industrial uses of the fiber in applications which require a relatively inelastic, tough, rot resistant material, such as fire hose covering.

U. S. Production

In the past, ramie has been grown extensively in the U. S., but only two companies are now engaged in its cultivation. Newport Industries, Inc., the largest U. S. producer, has about 2500 acres of ramie in the

News Digest

Florida Everglades and West Indies. Newport exports about 2/3 of its annual 3 million lb harvest of raw decorticated fiber to Europe and Japan. About 3/4 million pounds of degummed staple fiber is produced from the remaining million pounds of harvest and is sold in this country. Newport will up its 1954 production to about 4 million pounds, and hopes to sell quite a bit more fiber in the U. S. as new degumming facilities get rolling. Best encouragement for domestic fiber production comes from the Swift Manufacturing Co., a Georgia textile firm, currently using 3000 to 4000 lb of staple a week in textile fabric blends for upholstery and a rayon-cotton-ramie blend for apparel.

Cost

The cost of ramie is now down to about 70¢ a pound, and the chances for lower prices seem favorable as a result of growing volume and more economical production methods. At 70¢, ramie is nearly twice as expensive as cotton and rayon of comparable grade, but is cheaper than wool and nearly all of the synthetic fibers other than rayon. For many industrial uses, prices already may be competitive due to ramie's generally superior physical properties. The tensile strength of ramie is about three times that of hemp, four times that of flax, more than seven times that of silk, and about nine times the tensile strength of cotton. The elasticity of ramie is about the same as cotton, and is slightly more than either hemp or flax, but silk is nearly four times as elastic. Apparently, the only physical property in which ramie does not excel is torsion strength. Ramie has slightly more torsion strength than hemp and flax, but only 1/4 that of cotton.

XeroradiographyMay Widen Use of X-ray

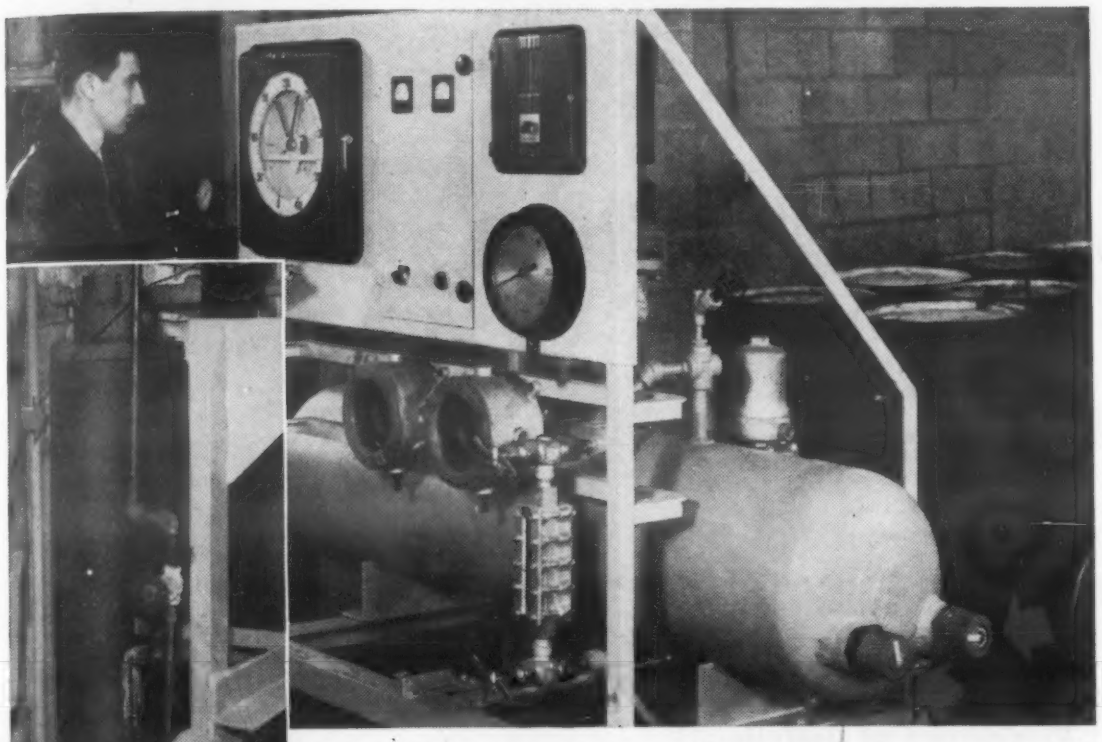
The first large scale field test of the industrial application of xeroradiography as an x-ray inspection technique is nearing completion. If the test proves as successful as early developments have indicated, it will be possible to extend radiographic inspection methods to many applica-

CHROMALOX Production TIPS

PROFITABLE IDEAS FOR BETTER PRODUCTION with ELECTRIC HEAT

HOW ELECTRIC HEAT REPLACED A STEAM SYSTEM

AND RESULTED IN INCREASED PRODUCTION AND CLOSER CONTROL



top Two 7½-Kw. screw-in type Chromalox Immersion Heaters heat Dowtherm for a high temperature jacketed still.

left One of five 40 Kw. Chromalox Circulation Heaters which replaced high pressure steam system.

After an evaluation of heat sources for new equipment and replacement required for increased production, a New York chemical manufacturer specified Chromalox Electric Heaters.

Chromalox Electric Immersion Heaters were installed for heating Dowtherm, used as a heat transfer medium in high-temperature jacketed stills. No expensive boiler system or piping was needed. In chlorinating reactor vessels, Chromalox Circulation Heaters replaced a high pressure steam system when increased production, closer control and higher operating temperatures were needed.

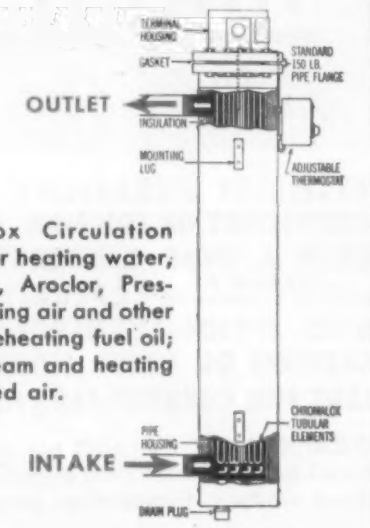
The company also equipped its new research building with Chromalox Heaters for *all* heating needs. Among advantages gained with Chromalox Electric Heat were: 1—Instant readiness for production; 2—exact temperatures; 3—accurate control; 4—around-the-clock reliability.

HOW TO GET MORE BTUs FROM BUNKER C OIL

Here's a tip that will save you money on oil-fired processing equipment. Heavier, less expensive fuel oils perform just as well as lighter, more costly grades if they are first preheated for thinning and consequent vaporization with Chromalox Circulation Heaters. These automatic heaters are simple to hook up, give real economy in steam boilers, furnaces, kilns and other equipment using fuel oil.

CHROMALOX ELECTRIC CIRCULATION HEATERS

The quick, comparatively low-cost solution to many industrial heating problems.

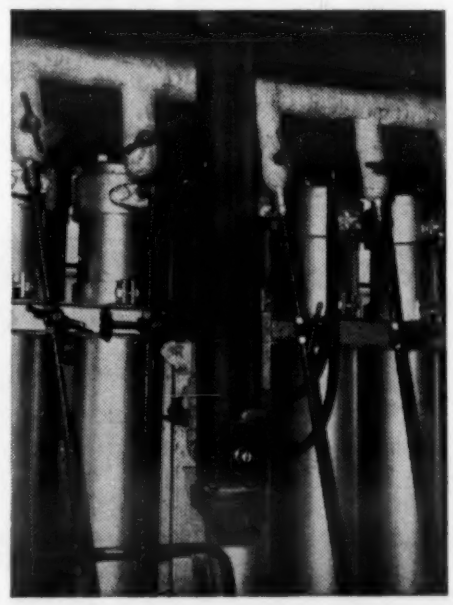


Chromalox Circulation heaters for heating water, Dowtherm, Aroclor, Prestone; heating air and other gases; preheating fuel oil; drying steam and heating compressed air.

REACTIVATING ALUMINA WITH ELECTRIC HEAT

A quick and easy way to automatically reactivate alumina used to dry oxygen is to connect the drying system to Chromalox Circulation Heaters. Nitrogen heated by the heaters passes through the moisture laden alumina and dries it for reuse. One company installed a 460 V, 3-phase, 9-Kw thermostatically controlled Chromalox Circulation Heater for the job. At 500° F. the heater cuts off automatically if nitrogen flow is restricted or stopped.

Chromalox Circulation Heaters, with element sheaths and internal construction of suitable metals, are used widely for heating air and other gases, for heating oil, superheating steam and heating water and other liquids.



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☐ Send me a complete Chromalox Catalog.
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News Digest

tions where conventional x-ray techniques are now impractical or too costly.

The system is adaptable to most existing x-ray installations. Since the process replaces conventional photographic film recording techniques, it is possible to realize considerable savings in material and processing costs.

Xeroradiography (pronounced zeroradiography) substitutes a reuseable metal plate for the conventional film or fluoroscope screen. The plate has a semiconducting layer on its surface, which is electrostatically charged before exposure. X-rays cause a change in the conductivity of the semiconductor, leaving the image as a pattern of differentially charged areas. A finely powdered resin or other dry developing material passed over the surface of the plate will adhere to the charged areas, producing a visible image. The image is available for inspection within 45 sec after exposure, and can be easily erased or transferred to ordinary paper as a permanent record. After inspection or transfer operations, the plate is cleaned and charged for reuse.

Developed at Battelle

Xeroradiography is a refinement of a dry photographic process (xerography) invented in 1937. In 1944 the Battelle Memorial Institute acquired exclusive rights to the patents and carried out initial developments which proved the practicality of the process. The Haloid Co. became interested in the method for use in office copying equipment and sponsored research leading to the development of a commercial version of the process which was put on the market in 1950. Early Battelle experiments in the application of xeroradiography for the direct recording of x-ray images showed promise of success, and an expanded research program supported by Haloid resulted in rapid progress in perfecting the technique.

The present field test is being conducted in a foundry operation of the Aluminum Company of America. The Haloid Co. and the X-Ray Division of General Electric are supplying the prototype xeroradiographic equipment.

Commercial Equipment

Xerographic, or xeroradiographic, equipment consists of plates, a sen-

"Yes...you can make it in stainless.

Free-Machining ENDURO is fully 90% as machinable as Bessemer screw stock"

You can give parts the high physical and chemical properties of ENDURO Stainless Steel—and, at the same time, maintain high rates of automatic production.

You do it by converting to ENDURO bars which are cold-finished by Republic's Union Drawn Steel Division. Two grades are fully 90% as machinable as Bessemer screw stock.

They offer close tolerance, accuracy of section, uniform soundness, and fine surface finish.

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sitizing or charging device, a developing chamber, transferring equipment (if permanent records are needed), and facilities for cleaning the plates. All this is contained in a single box no more than two feet square in Haloid's office copying device. Commercial xeroradiographic equipment is reportedly nearing final development and should be on the market within a year.

Principles of Xerography

A xeroradiograph plate consists of a thin layer of a radiation-sensitive semiconductor (such as selenium) on a heavy, conducting, backing plate. Aluminum is used as a backing plate in the equipment under test. The semiconducting layer is an excellent insulator in the absence of radiation, and has high dielectric strength. In the presence of x-radiation, the resistivity of the layer is decreased by a factor of 100 to 100,000 or more, as a function of the intensity of radiation.

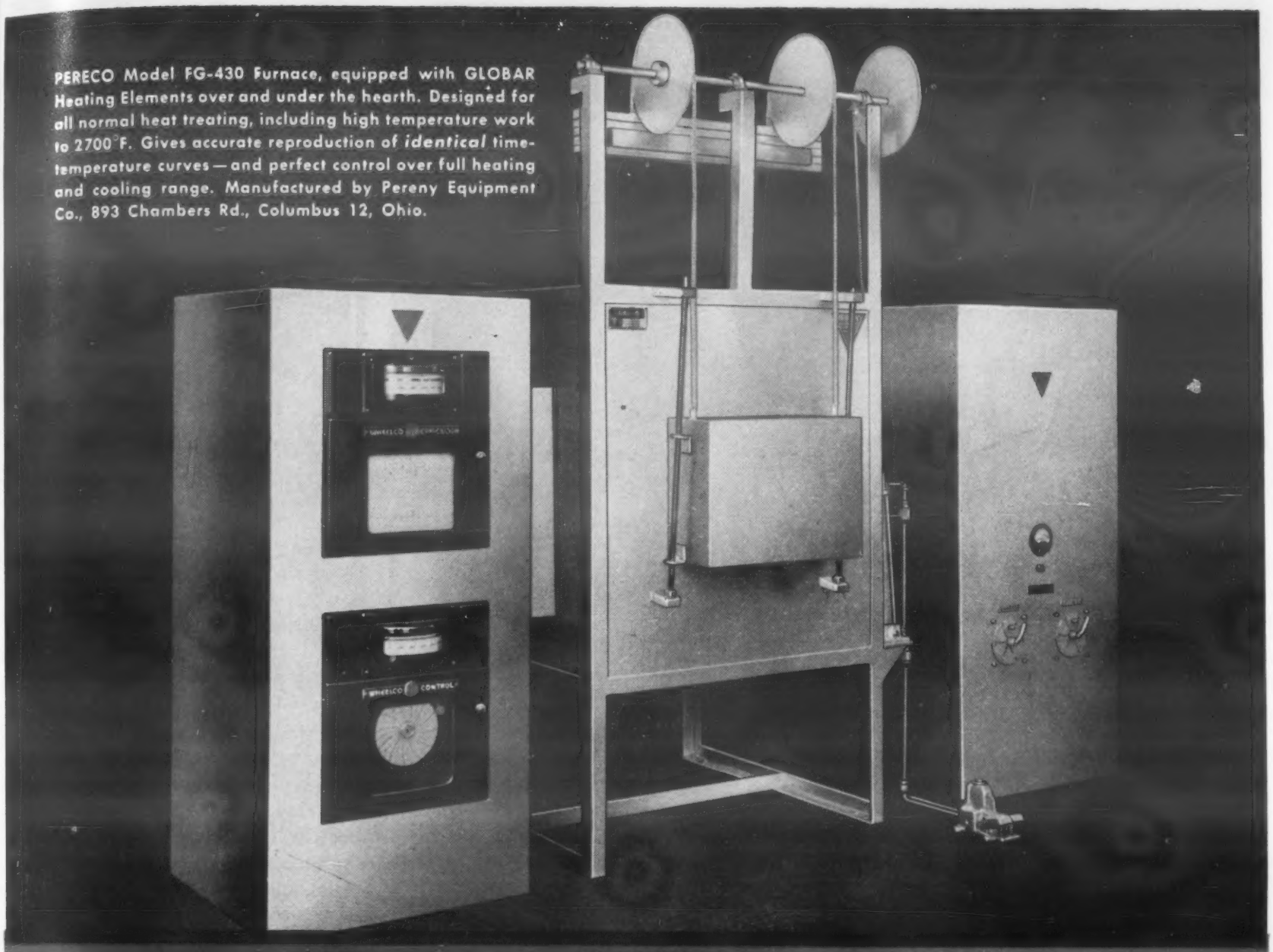
To sensitize the plate, an electrostatic charge is placed on the surface of the semiconducting layer by passing the plate beneath fine wires charged with a potential of about 7000 volts. The plates retain their charge for surprisingly long periods of time.

When the charged plate is exposed to radiation, areas of the semiconducting layer become conductive in proportion to the amount of radiation they receive. The electrostatic surface charge leaks through to the backing plate due to the increased conductivity, and variations result in the electrostatic potential of the surface of the plate. The image is made visible by exposing the plate surface to a charged powder cloud or cascading a suitable powder across it. The image may be inspected on the plate, or transferred to paper by adhesive or electrostatic methods.

Sensitivity and Definition

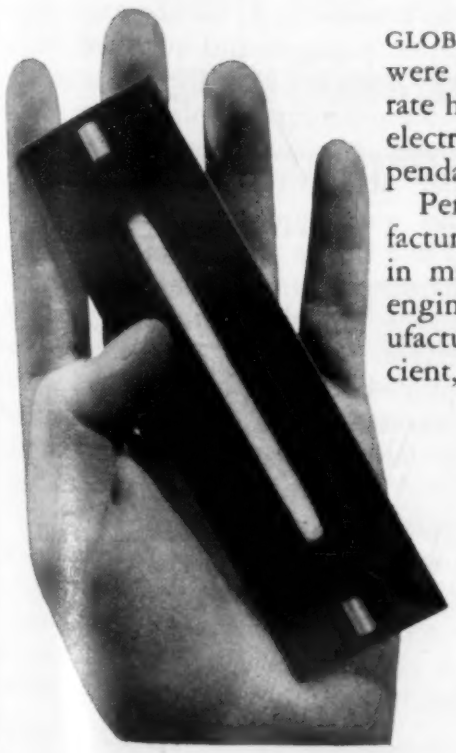
A 1951 report on selenium xeroradiographic plates developed at Battelle reported sensitivity through the range of 5 to 10,000 KVP as being from two to seven times that of type M (high-contrast, fine-grain) no-screen x-ray film. Xeroradiographs comparable to film images were attained satisfactorily by reducing either the exposure time or the KVP.

Using powder cloud development



PERENY selects GLOBAR® Heating Elements

. . . for this High Temperature Heat Treating Furnace



GLOBAR Silicon Carbide Heating Elements were chosen by Pereny for this modern, accurate heat treating furnace because they convert electrical energy into clean, safe, uniform, dependable heat.

Pereny is one of 40 leading furnace manufacturers who specify GLOBAR Heating Elements in many of their electric furnaces. GLOBAR's engineering staff works closely with these manufacturers to give *you* the most modern, efficient, and economical equipment for industrial heating processes—whether it be heat treating, brazing, annealing, forging or sintering.

Any problem you may have in the medium and high temperature range of industrial heating will be tackled vigorously by our engineers . . . without obligation to you. The solutions they propose often result in much lower overall operating costs—even when electricity costs more than other fuels! Write to the GLOBAR Division, Dept. MM 87-42, The Carborundum Company, Niagara Falls, N. Y.

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techniques continuous tone images were produced on the plates comparable to excellent photographic prints on bromide papers. Contrast sensitivity of 2% was attained in tests using a wide range of materials and thicknesses.

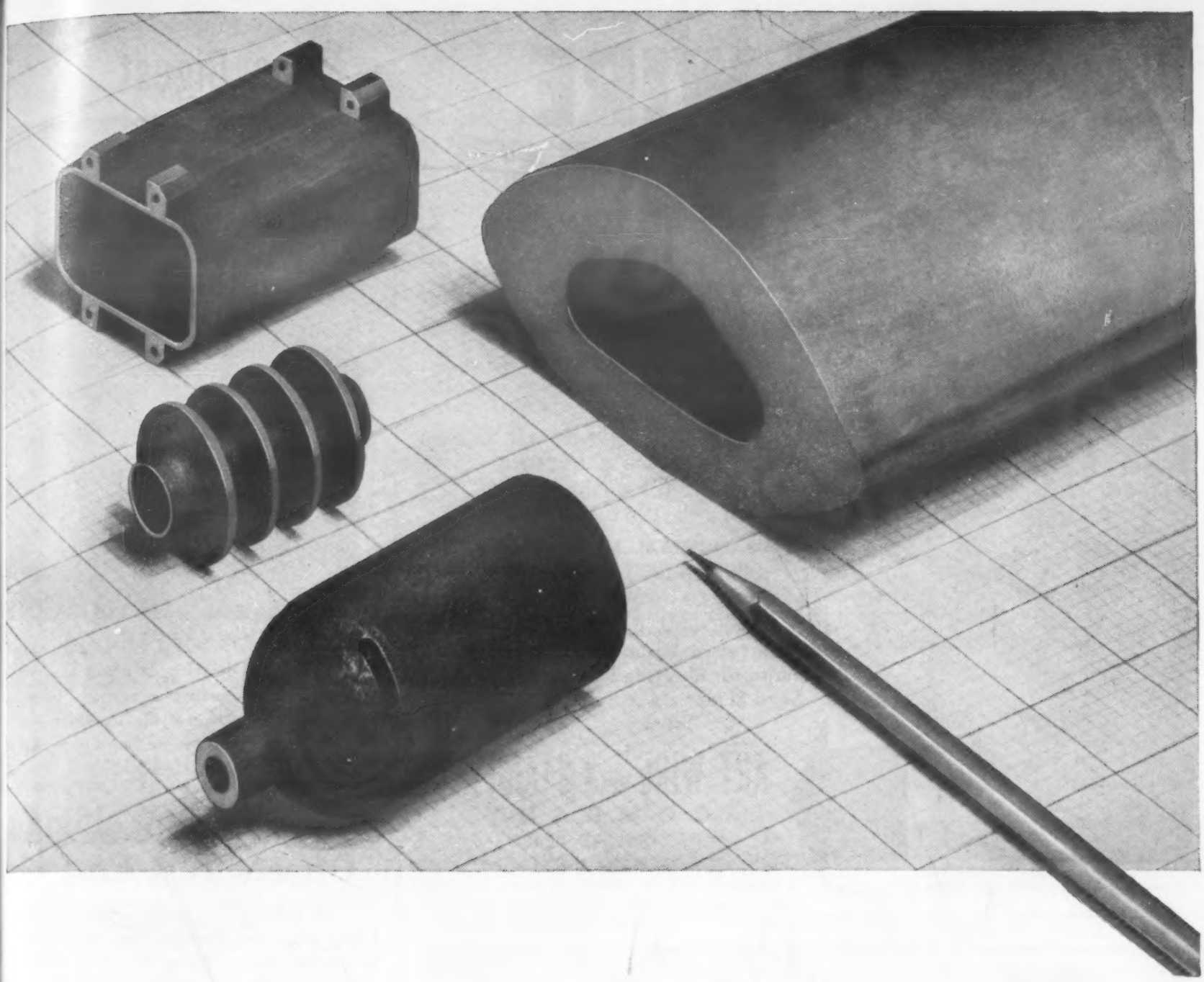
The Battelle scientists have regularly produced images having a line definition in the range of 380 to 1270 lines per inch (commercial electroplates used in printing the photographs appearing in this magazine have a screen of from 90 to 120 lines per inch). Xeroradiographs are particularly good for showing up well-defined line cracks or sharp edges, as the nature of the electrostatic field at the juncture of two contrasting areas on the plate causes an increase in density at the boundary.

Practicality

Xeroradiographic techniques appear to offer several advantages over standard x-ray film. The plates may be used over and over for hundreds of successive exposures, saving material and processing costs associated with standard techniques. Xerographic plates, unlike film, are not permanently damaged or spoiled by accidental exposure to x-rays or nuclear radiation. Images are available within a few seconds of exposure, minimizing record keeping and the possibility of mix up. No wet processing or liquid chemical solutions are needed, and the developing process is relatively insensitive to changes in temperature and humidity. The images are easily and readily transferred to low cost permanent recording media such as ordinary paper. Paper, pigment and adhesive are the only supplies actually consumed.

Xeroradiograph plates are similar enough to conventional x-ray film so that standard exposure conditions and x-ray equipment can be used. While it was at one time feared that humid conditions would tend to discharge the plates and otherwise interfere with the operation, recent work has completely solved that problem and no adverse effects from humidity are experienced with the latest equipment. The process appears to be very practical for production line inspection in foundries and other high-volume production situations where x-ray inspection might be valuable, but is now uneconomic due to the unit costs of x-ray prints.

(Continued on page 216)



LET CARBONEERING BY SPEER help you with new solutions to your parts problems

You be the judge of carbon's versatility

Carbon can be:	Carbon has:
Sawed	High corrosion resistance
Drilled	High heat transfer
Milled	Low electrical resistance
Broached	High thermal shock resistance
Turned	High heat transfer (graphite)
Planed	Carbon is:
Hobbed	Not wetted by molten metals
Ground	Non-warping
Molded	Chemically inert
Extruded	Self-lubricating (graphite)

Stumped by materials shortages?

Try *carboneering*—the development of carbon or graphite parts and designs for your application. Speer engineers have made carbon perform many new and interesting tasks for many industries.

For example—this special electrode Speer developed for use in milk pasteurizing equipment. With a weight of 15 pounds and a length of 25 inches, this electrode of impervious graphite has the high heat transfer and low electrical resistance necessary for low-cost, controlled heating of large volumes of fluid milk.

And, in contrast, the lightweight graphite anodes used in various types of electronic tubes have many advantages over materials they have replaced. They do not warp under high loads, they have superior heat radiation and they are nonmagnetic—a vital consideration in the design and manufacture of cathode ray tubes for television.

These are only two examples from two industries of the many parts and applications *carboneered* by Speer. If you have a design problem—or if shortages of critical materials are interfering with production—let Speer help you *carboneer* a practical solution. Send us full details.

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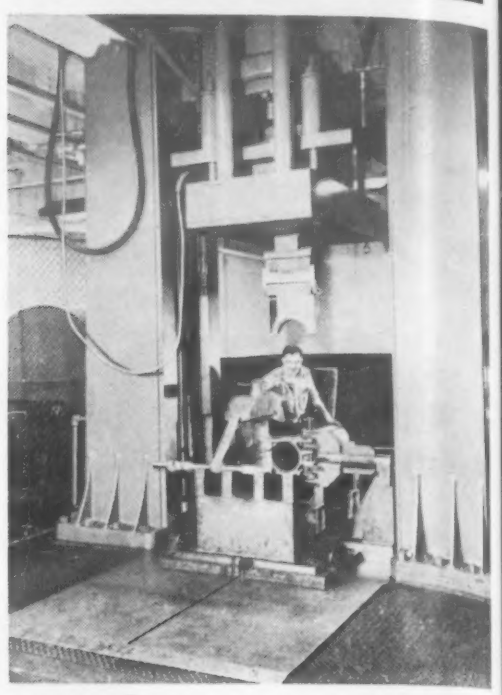

FLASH BUTT WELDED landing gear cylinder and bearing is proof tested in 1,000,000 lb testing machine. Test is part of production cycle in which each welded assembly is tested up to 80% of material yield strength.

Flash Butt Welding Offsets Test Cost

In fabricating large aircraft landing gear components, flash butt welding of large diameter steel tubing to mating drop forgings has proved economical enough to offset costs of 100% proof testing.

The Cleveland Pneumatic Tool Co. has installed a 1,000,000 lb hydraulic testing machine to proof test the welds in large assemblies, and reports that the testing program is fully justified as a result of the considerable savings realized through the use of built-up components compared to the cost of forging and machining a single piece. The process not only cuts costs, but the forgings can be handled by smaller forging machines and dies, permitting procurement from a larger number of suppliers.

The production-testing facilities are capable of handling flash butt welds with cross sectional areas up to 67 sq in. and diameters up to 30 in. Welds are proof tested on a standard floor mounted Baldwin-Lima-Hamilton machine of type that carries all loading and load measuring components on cross head.

Landing gear components currently in production include a landing gear piston and strut bearing. The piston is 10½-in. o.d. steel tubing with a ½-in. wall. Tests are conducted after excess flash has been removed and the welded assembly heat treated.

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MANUFACTURERS' LITERATURE

Surface Roughness Indicators. Micrometrical Mfg. Co., 4 pp, ill. Booklet entitled "How to Win Arguments on Surface Roughness" describing the values of instrumentation. (49)

Belt Grinding. Minnesota Mining & Mfg. Co., 12 pp, ill. Describes the 3M method of belt grinding and finishing using coated abrasive belts as a means of high-speed grinding and finishing of flat or contoured surfaces. (50)

Power Brush Finishes. Osborn Mfg. Co., 4 pp, ill. Automatic deburring by power brushing techniques. (51)

Carburizing. Park Chemical Co., 4 pp, Technical Bulletin B-1. Description of various methods of pack carburizing of steel in solid compounds. (52)

Densified Wood. Parkwood Laminates Inc., 4 pp, ill. Description and physical properties of various high density wood laminates. (53)

Phosphate Coatings. Pennsylvania Salt Mfg. Co., 5 pp, ill. Description of the Fosbond process of phosphate coatings for metal finishing. (54)

Precision Shapes. Precision Shapes Inc., 6 pp, ill. Fabrication process for continuous milling of shapes from solid rolled, drawn or extruded stock. (55)

Paint Spray. Ransburg Electrocoating Corp., 16 pp, ill. Description of electrostatic spray paint process for automatic industrial applications. (56)

Surface Treatment. N. Ransohoff, Inc., 4 pp, ill. Equipment for washing, pickling, neutralizing metal parts prior to plating. (57)

Insulating Material. Rubatex Div., Great American Industries Inc., 5 pp, No. R1552. Results from investigation to determine the performance of Rubatex insulation in sub-zero temperatures. (58)

Industrial Textiles. Schlegel Mfg. Co., 12 pp, ill. Description of research and production facilities available for industrial textiles. (59)

Welding Machines. Sciaky Bros. Inc., 5 pp, ill. Description of multiple gun electrical resistance welding machines. (60)

Aluminum Strip. Scovill Mfg. Co., 20 pp, ill. Description of Truspec aluminum alloy strip with charts of physical and mechanical properties of various aluminum alloys. (61)

Molded Rubber. Spencer Rubber Products Co. Facilities for molded rubber design development and production. Includes rubber specifications chart for selection of proper rubbers. (62)

Belt Conveyors. Standard Alloy Co., 3 pp, ill, No. 3. Furnace belt conveyors utilizing nickel chromium castings. Includes belt loading chart. (63)

Nickel Clad Copper Wire. Sylvania Electric Products Co., 8 pp, ill. Nickel clad copper wire for use with high temperatures. (64)

Cold Rolled Steel. Thomas Strip Div., Pittsburgh Steel Co., 50 pp. Complete table on pound for lineal foot in weight for cold rolled strip steel in widths of 1/4 in. to 24 in. and thicknesses from 0.001 to 0.2757. (65)

Brazing Alloy. United Wire and Supply Co. Folder on physical and chemical properties of Phoson low temperature brazing alloys. (66)

Low Temperature Equipment. Webber Appliance Co., 8 pp, ill. Description of low temperature industrial freezers and complete temperature range testing units. (67)

Metal Powder Parts. Wel-Met Co., 4 pp, ill. Advantages and limitations of powder metal machine parts. Includes numerous examples. (68)

Other Available Literature

Irons and Steels • Parts • Forms

Metal Powder Parts. American Sintered Alloys Div., Yale & Towne Mfg. Co., 6 pp, ill, No. 352. Shows a variety of ferrous and nonferrous metal powder parts fabricated by this company. (71)

Steel Casting Design. Atlantic Steel Castings Co., ill. Offers detailed information on how to economically design steel castings. (72)

Precision Investment Castings. Cannon Muskegon Div., Nugent Sand Co., Inc., 4 pp, ill. Gives the many advantages of using Master Met certified alloys in precision investment casting operations. (73)

Stainless Steel. G. O. Carlson Inc., 6 pp, ill. Discusses the facilities of this company for producing stainless steels, tailor-made to whatever size and shape required. (74)

Rolled and Welded Parts. The Cleveland Welding Co., 8 pp, ill. Describes welded circular and rolled steel parts, their advantages in economic and physical aspects and their applications. (75)

Weldments. Continental Foundry & Machine Co., 6 pp, ill. Discusses fabricated steel weldments, composite welded assemblies of fabricated steel plate and castings, and cast welds assembled entirely of castings. (76)

Metal Stampings. Dayton Rogers Mfg. Co., 24 pp, ill. Metal stampings in small lots. Suggested design features, tolerances, cost analysis. (78)

Permanent Magnets. Indiana Steel Products Co., 8 pp, ill, Vol. 1, No. 2. "Applied Magnetics" features two brief articles on permanent magnets. (79)

Stainless-Clad Steels. Ingersoll Div. of Borg-Warner Corp. Folder describes Ing-Clad 20% cladding of stainless steel bonded to backing of carbon steel. (81)

Metal Rings. King Fifth Wheel Co. Catalog and capacity charts of this company's facilities for bending and welding metal rings for industrial purposes. (82)

Plate and Sheet Metal Products. Littleford Bros. Inc., 8 pp, ill, No. MP-39. Profusely illustrates a complete line of plate and sheet metal products fabricated by this company. (83)

Metal Powder Parts. Metal Powder Products, Inc., 4 pp, ill. Features a variety of applications for iron, iron-copper, and bronze sinterings produced by this company. (84)

Threaded Stampings. Mohawk Mfg. Co., 2 pp, No. 851. Illustrates variety of products produced by Mohawk's stamping processes, guaranteeing uniform threaded parts with uniformly threaded holes. (85)

Plastic Coated Metal Tubing. Samuel Moore & Co., 4 pp, ill, No. F-2008. Describes properties, fabrication, available forms and fittings of Dekoron, plastic coated metal tubing with numerous uses. (86)

Cold Extruded Steel Parts. Mullins Mfg. Corp., Koldflo Div., 28 pp, ill, No. 4334. Product design guide to the many new commercial applications of the Koldflo process of cold shaping steel by displacing metal under compression. (87)

Cold-Roll Formed Parts. National Metal Products Co., 4 pp, ill. Describes facilities of this company for producing cold-roll formed products. (88)

Precision Investment Castings. National Precision Casting Corp., 4 pp, ill. Pictures various steps in the precision investment casting process offered by this company that saves time and money. (89)

Seamless Steel Tubing. National Tube Div., U. S. Steel Co. Explains time- and cost-cutting fabricating applications of this company's Shelby seamless tubing. (90)

Metal Powders. Plastic Metals Div., 4 pp, ill, No. 567. Describes applications, advantages and limitations of powder metallurgy as used by this firm for custom making parts. (91)

Electric Welded Pipe. Republic Steel Corp., 20 pp, ill, No. ADV-521. Detailed description of manufacturing process, advantages, structural and mechanical applications on pipe made by electric weld method. (92)

Wire Cloth. Reynolds Wire Co., 8 pp, ill, No. 1a/30a. Available materials, styles and sizes of industrial wire cloth, furnished in ferrous and nonferrous materials. (93)

Steel Tubing. Rochester Products Div., General Motors, 12 pp, ill, No. 271. Features typical applications of GM tubing made in both single and double walls of steel. (94)

Sheet Metal Fabrication. Stolper Steel Products Corp., 4 pp, ill, No. 2. Features case histories of sheet metal design and fabrication offered by this company. (95)

Steel Weldments. Struthers Wells Corp., Process Equipment Div., 16 pp, ill, No. W52553. Profusely illustrates a complete line of steel weldments engineered and fabricated by this company. (96)

Precision Machined Parts. Stryker Machine Products Co., 4 pp, ill, No. E-360. Profusely illustrates the facilities of this company for producing precision machined parts. Includes an equipment and capacity list. (97)

Steel Tubing. Summerill Tubing Co., Div. Columbia Steel and Shafting Co., 8 pp, ill. Cold drawn steel tubing for hydraulic applications. (98)

Graphitic Steel. The Timken Roller Bearing Co., Steel & Tube Div. Data on properties and applications of graphitic steels in Timken Graphitic Steel Data Book. (99)

Small Precision Metal Parts. Torrington Co., 4 pp, ill. Illustrates the various small precision metal parts custom-made by the Specialties Div. of Torrington. (100)

MANUFACTURERS' LITERATURE

Spun Metal Parts. Roland Teiner Co., Inc., ill, No. 51D. Brochure describes this company's facilities for spinning practically any metal or gage required. (101)

Permanent Magnets. Thomas & Skinner Steel Products Co., Inc., 12 pp, ill. Alnico 2, 3 and 5 standard magnets in stock. Bars, rings, channel bars, horseshoe shapes. Tables of magnetization curves, energy curves and physical properties. (102)

Ferro-Alloys and Metals. Vanadium Corp. of America, 24 pp, ill. "The Vancoram Review" presents technical articles on applications and developments in ferro metallurgy especially concerned with vanadium alloys. (103)

Weldments. The Van Dorn Iron Works Co., 10 pp, ill. Shows this company's facilities for producing weldments and other parts in all sizes and shows examples of the type of work produced. (104)

Stainless Steel Castings. Waukesha Fundry Co., 4 pp, ill, No. WF-5. Shows facilities of this company for producing any hard-to-shape type of stainless steel castings. (105)

Magnetic Alloys. Westinghouse Electric Corp., 8 pp, No. TD 52-100. Complete data on a variety of magnetic alloys produced by this company includes applications and 15 core loss and magnetization curves. (106)

Nonferrous Metals • Parts • Forms

Aluminum Parts. Aluminum Goods Mfg. Co., 56 pp, ill. Catalog covers extensive production facilities and technical services for producing wide range of parts. (112)

Certified Die Castings. American Die Casting Institute Inc. Discusses plan to protect zinc alloy die castings buyers by subjecting producers' products to regular testing. (113)

Precision Investment Castings. American Precision Casting Corp., 8 pp, ill. Shows the steps involved to obtain precision investment castings using the "lost wax" process. (114)

Specialty Metals. American Silver Co., Inc., 4 pp, No. 9B. A brief listing and description of products which include ultra-thin gage metals, clad metals, contact materials and brazing alloys. (115)

Continuous Cast Bronzes. American Smelting and Refining Co. Catalog gives physical properties, photomicrographs, tables of available shapes and sizes, weights and other technical data. (116)

Small Tubular Parts. The Bead Chain Mfg. Co. Describes Multi-Swage Process for economically custom producing small mechanical parts up to ¼-in. dia and 2-in. length. (117)

Magnesium. Brooks & Perkins Inc., 8 pp, ill. Describes the facilities and services of this company for fabricating magnesium. (118)

Thermostatic Bimetals. W. M. Chace Co., 8 pp, ill. Paper on the fundamentals of bimetal performance, which was presented recently at the AIEE Appliance Technical Conference. (119)

Investment Castings. Gray-Syracuse, Inc., 4 pp, ill. Various parts of precision cast brass, bronze, beryllium copper and steel. (120)

Wire Thread Inserts. Heli-Coil Corp., 8 pp, ill, No. 660. Lists advantages of using Heli-Coil stainless steel wire thread inserts in tapped holes. (121)

Aluminum Alloy. William F. Jobbins Inc., 12 pp, ill. Includes advantages, composition, physical properties and applications of Almag 35, an aluminum casting alloy of the aluminum magnesium types. (122)

Titanium Carbide. Kennametal Inc., 6 pp, ill, No. 1051. Properties and outstanding characteristics of Kentanium, titanium carbide said to have excellent resistance to heat. Indicates wide variety of possible forms. (123)

Silicon Bronze. R. Lavin & Sons Inc., 8 pp, ill, Vol. 9, No. 1. "The Lavingot" contains an interesting article on the subject of silicon bronze. (124)

Die Castings. Madison-Kipp Corp., 32 pp, ill. Describes company's aluminum and zinc die castings. Also shows Kipp Feather-weight air grinder and Fresh-Oil lubricators. (125)

Magnesium. Magline Inc., 8 pp, ill. Facilities for fabricating magnesium and producing sand castings. (126)

Magnesium Parts. Magnesium Products of Milwaukee, 4 pp, ill. Briefly describes facilities for designing and producing to order magnesium and aluminum parts. Shows several products. (127)

Tin Information. Malayan Tin Bureau, 22 pp, ill. Detailed information on the availability of tin, including world production, consumption, stocks and prices. (128)

Ferrous and Nonferrous Metal Forms. Metal Goods Corp., 274 pp. Complete stock list and ordering information on metal parts and forms supplied by this company. (129)

Sintered Metal Bearings. Michigan Powdered Metal Products, Inc., 2 pp, ill. Describes sintered metal bearings with cavities in bearing walls to enable greater oil content and heavier bearing loads. (130)

Aluminum and Zinc Castings. Monarch Aluminum Mfg. Co. File pages on this company's developments in aluminum and zinc castings. Each folder distributed kept up-to-date. (131)

Bronze and Babbitt Metals. National Bearing Div., 2 pp. Price lists of "Tiger Bronze" cored and solid bars and babbitt metals, all for bearing usage. (132)

Precious Metal Wire. The J. M. Ney Co., 2 pp. Technical data on advantages of using Ney-Oro 6, precious metal wire for pivots in instrument bearings. (133)

Die Castings. Paramount Die Casting Co., 4 pp, ill. Facilities of this company for producing aluminum, magnesium and zinc die castings. (134)

Investment Castings. Precision Metalsmiths Inc. Entitled "Pour Yourself an Assembly," this booklet describes this company's facilities for casting in 160 different ferrous and nonferrous alloys. (135)

Bushings. Randall Graphite Bearings, Inc., 12 pp, ill, No. 100. Complete price list of bronze bushings and specially grooved bushings; specifications of bored and solid bronze bars. (136)

Machining of Titanium. Rem-Cru Titanium Inc., 8 pp, ill, Vol. 1, No. 1. Discusses titanium machining practices and procedures recommended by customers having titanium application experience. (137)

Roll Formed Shapes. Roll Formed Products, 24 pp, ill, No. 1053. Shows production procedures and advancements in roll forming shapes from ferrous and nonferrous metals. (138)

Die Castings. Tri-State Die Casting Corp. New folder describes this company's facilities for production of aluminum and zinc die castings to order. (139)

Centrifugal Castings. Wisconsin Centrifugal Foundry Inc., 8 pp, ill. Foundry for centrifugal castings includes semi-machining and finish machining services. Chart of most widely used alloys: aluminum bronzes, manganese bronze, tin bronze and aluminum alloys. (140)

Nonmetallic Materials • Parts • Forms

Plastic Moldings. Accurate Molding Co. Describes facilities for producing precision plastic moldings. Case histories given. (143)

Honeycomb Material. Aircomb Section, Douglas Aircraft Co., Inc. Announces the development of Aircomb, a honeycomb structure of Kraft paper impregnated with a phenolic resin. Pre-cut in any thickness from 1/16 to 5 in., it is said to be 16 times as rigid as an equal weight of steel, durable, fire-resistant, pest-resistant and has excellent insulation and soundproofing properties. (144)

Extruded Plastics. The Anchor Plastics Co., 8 pp, ill, No. AP51. Shows numerous applications of extruded thermoplastics and brief characteristics to aid in selection. (145)

Plastic Pipe. Anesite Co., 2 pp, ill. Specifications and applications of Black-Buty plastic pipe, designed to combat corrosion and avoid parafin build-up in gathering lines and salt water disposal systems. (146)

Gasket Materials. Armstrong Cork Co., 24 pp, ill. Complete data on various cork and rubber gasket materials made to meet government specifications. (147)

Plastics Forms. Cadillac Plastic Co., 12 pp. Size sheets and price lists of Cadillac's plastics materials supplied in sheet, rod and tube. (148)

High Strength Plastics. Continental-Diamond Fibre Co., No. GF-50. Properties, descriptions and applications of five of this company's high strength plastics. (149)

Glass Fiber Products. Dynakon Corp., 4 pp, ill. Booklet gives advantages, applications and uses of Dynakon, a high strength, plastic bonded, glass-fiber product produced in form of sheets, rods and molded sections. (150)

Felt and Felt Products. Felters Co., 16 pp, ill. Includes properties, applications and specifications of felt as a design material and various felt products. (151)

Teflon Plastic. Dixon Saddle Co., 3 pp. Chemical, electrical and nonadhesive properties of Teflon, which is available in rods and tubes and can be extruded to any desired length. (152)

Plastics Parts. Franklin Plastics Div. of Robinson Industries, Inc., 6 pp, ill. Illustrates variety of plastics products and discusses this company's injection molding facilities. (153)

MANUFACTURERS' LITERATURE

Setting Compound. Furane Plastics Inc., 1 p, No. A-2-52. Data on Furane Resin X-2, in conjunction with activated silica, which forms a remarkably fast setting compound. (154)

Plastics. General Industries Co., 16 pp, ill. Profusely illustrates the facilities of this company for producing a wide variety of low-cost custom-molded plastics. (155)

Rubber-Cushioned Parts. General Tire & Rubber Co., 12 pp, ill. Describes General Silentbloc method of mounting, coupling or isolating moving machinery on rubber. Shows standard parts and specifications. (156)

Fiber Glass for Vibration Resistance. Glass Fibers Inc., 8 pp, ill. Physical and chemical properties of Vibraglass, used in the new glass fiber shock and vibration absorbing machinery pads produced by Glass Fibers. (157)

Plastic Molding. The Grigoleit Co. Folder describes this company's facilities for producing molded plastics. Includes designing, engineering, tooling, molding and finishing. (158)

Industrial and Laboratory Chemicals. The Harshaw Chemical Co., 16 pp, ill. Chemicals for catalysis, electroplating and other uses. Pigment and ceramic materials, synthetic optical crystals. Descriptions of research facilities. (159)

Corrosion Resistant Equipment. Haveg Corp., 16 pp, ill, No. C-10. Pipe, valves, pumps, fume systems, filters and condensers for corrosive installations. (160)

Plastics. Heil Process Equipment Corp., 3 pp, ill, Nos. 752, 753 and 754. Discusses the use of Rigidon plastics exhaust heads, duct fittings and ventilating ducts. Specifications included. (161)

Plastics. Heresite & Chemical Co., 24 pp, ill. Oil-free thermosetting phenolic coatings, thermosetting and thermoplastic resins, molding compounds, synthetic rubber coating sheets and molded forms. (162)

Rigid Polyvinyl Chlorides. Kaykor Industries Inc., Div. of Kaye-Tex Mfg. Corp., 6 pp. Chemical and physical properties of Vyflex rigid polyvinyl chloride plates and sheets. (163)

Glass. Kopp Glass Inc., 18 pp, ill. Methods by which Kopp glass products are designed and made to meet strict specifications for light transmission and distribution, physical properties, dimensional exactness and other requirements. (164)

Polystyrenes. Koppers Co., Inc., No. C-2-169. Features a table giving all the properties of a complete line of straight and modified Koppers polystyrenes. (165)

Industrial Lens. Lancaster Lens Co., 4 pp, ill. Shows a variety of industrial glass products produced by this company, and lists the many industries it serves. (166)

Luminescent Plastics. Luminescent Plastics Corp., 7 pp, ill. Illustrates wide variety of products of luminescent plastic material. (167)

Glass Products. McKee Glass Co., 16 pp, ill, No. 12-68. Describes types of glasses manufactured, their applications and facilities for large-scale production. Illustrates numerous products for home and industry, including electrical, laboratory, television and marine equipment. (168)

Hardboards. Masonite Corp., 24 pp, ill, No. 1d/2. Properties and advantages of Preswood and other Masonite hardboards, and their relation to product design. (169)

Self Lubricating Bearings. Metallized Carbon Corp., 4 pp, ill. Includes typical mechanical and electrical applications of self-lubricating bearings made of metallized carbon-graphite. (170)

Plastics Tubing. Elmer E. Mills Plastics, Inc., 8 pp, ill. Describes this company's plastic tubing, piping and fittings, including some fabricating data and detailed corrosion information. (171)

Molding and Extrusion Compounds. Naugatuck Chemical Div., 3 pp. Folders of technical data sheets on properties, features, uses and handling methods of Kralastics, plastic and elastomeric combinations. (172)

Rubber. Ohio Rubber Co., 4 pp, ill, No. F-426. Detailed tabulation of the properties of natural rubber and rubberlike material. (173)

Laminated Resinous Plastics. Panelyte Div., St. Regis Sales Corp., 19 pp, ill. Physical properties, industrial and chemical applications and fabrication of laminated thermosetting resinous plastic. (174)

Nylon. Polymer Corp., 2 pp, ill, No. 13. Technical data on the use of Polypenco nylon in various applications. (175)

Corrosion Resistant Gasketing. Products Research Co., 5 pp, ill. Features, advantages and specifications of Chromelock corrosion resistant gasketing material. (176)

Flexible Metallic Packings. Raybestos Manhattan, Inc., 8 pp, ill. Includes service recommendations and specifications of a complete line of R. M. flexible metallic packings. (177)

Adhesives. Rohm & Haas Co., 10 pp, No. 20R. Describes in detail Uformite 400, a high-solid, aqueous urea-formaldehyde resin adhesive especially designed for bulk shipment and storage. (178)

Fibrous Sheet Materials. Rogers Corp., 19 pp, ill. Data sheets on Rogers Duroids giving properties, test values and applications of each particular Duroid. (179)

Extrusion of Plastics. Sheffield Plastics, Inc., 2 pp, ill. Describes custom service for producing rods, tubes and other thermoplastic shapes to order. (181)

Molded Ceramics. Star Porcelain Co. Gives technical data on characteristics of molded ceramic products for electrical wiring, electrical heating and special purposes. (182)

Machining Laminated Plastics. Synthane Corp., 6 pp, ill. Recommended techniques for common machining operations on laminated plastics. Includes properties and design hints. (183)

High Temperature Insulation. H. I. Thompson Co., 34 pp, ill. Detailed technical data on Refrasil, giving case histories on performance characteristics as a high temperature insulator. (184)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on pages 225 or 226

Carbon Graphite. U. S. Graphite Co., 4 pp, ill. Describes Graphitar, carbon-graphite nonmetallic that is chemically resistant, self-lubricating, hard, light and won't warp. (185)

Plastic Tubing. U. S. Stoneware Co., 23 pp, ill. No. T-77. Discusses engineering properties and uses of vinyl plastic materials in extruded form. (186)

Felt. Western Felt Works, 32 pp, ill. History of manufacture and uses of felt, including brief description of present-day methods and applications. (187)

Plastic Laminates. Winner Mfg. Co., Inc., 12 pp, ill. Features the varied facilities of this company and gives typical applications of its many plastic low-pressure laminate products. (188)

Finishes • Cleaning and Finishing

Buffing Compound. Apothecaries Hall Co., 2 pp, No. B-1. Information on grease-type buffing bars for use on polished surfaces or surfaces with uniform roughness, *e. g.* stamped, drawn or rolled. (192)

Rust-Inhibiting Paint Base. Bell-Ray Chemical Corp., 4 pp. Features advantages of using Chem-Bond, a rust-inhibiting paint base, on iron, steel, brass, copper, aluminum, etc. (193)

Resin-Bonded Laminates for Finishing. The Chemical Corp., 20 pp, ill, No. PD-1R353. Data sheets discuss a variety of tanks, ducts, hoods, stacks and waste pipe for corrosion resistant use. (194)

Black Oxide Finish. Du-Lite Chemical Corp. Information on Du-Lite finishes for any steel blackening problem. Also gives information on Du-Lite cleaner, strippers, burnishing compounds, etc. (195)

Vitreous Enamel for Aluminum. E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Dept. Presents complete information on vitreous enamel for aluminum. (196)

Wear Resistant Coating. Electrolyzing Corp., 16 pp. Detailed data on the Electrolyzing Process for increasing the life and efficiency of metal parts subjected to wear, abrasion and corrosion. (197)

Abrasive Stone. Elgin National Watch Co., Industrial Products Div., 1 p, No. 101. Price list of silicon carbide and aluminum oxide abrasive stones for stoning tools and dies, prefinishing and changing molds. (198)

Protective Coating. Flexrock Co., Protective Coating Div., 4 pp, ill. Complete data on Flexcoat 311, a vinyl-acrylic base industrial coating that stops corrosion and contamination. (199)

Protective Coatings. Industrial Metal Protectives, Inc. Illustrated brochure describing Zincilate, which can be applied by spray, brush dip or flow coat methods to new products or existing structures. (200)

Burring Metals. The Lea Mfg. Co., 6 pp. Standard practice for ferrous and nonferrous metals, also instructions as to which wheel and compound to use in burring. (201)

Protective Coatings. Magic Chemical Co., 22 pp. Applications and methods of use of Magic-Vulc anti-abrasion and anti-corrosion plastic rubber coatings. (202)

MANUFACTURERS' LITERATURE

Coating for Zinc Surfaces. Neilson Chemical Co., No. 48-49. Describes Galvaprep, coating providing good adhesion of paint on galvanized iron, other zinc-coated surfaces. (203)

Metal Cleaner. Niagara Alkali Co. Pamphlet gives properties of Nialk Trichlorethylene, high quality metal-cleaning and degreasing agent. (204)

Protective Coating. Nox-Rust Chemical Corp., 4 pp, ill. Describes Nox-Rust 310-AC protective coating for metal parts. Easily applied, said to afford good protection up to 90 days. (205)

Wear Resistant Coating. Parker Rust Proof Co., 12 pp, ill, No. A1062. Advantages of using Parco Lubrite, method of applications, typical coating equipment and typical parts that are benefitted. (206)

Vapor Degreasing Equipment. Phillips Mfg. Co., 21 pp, ill. Handbook gives a detailed description of vapor degreasing process, the materials used, its applications, advantages and limitations. (207)

Industrial Brushes. Pittsburgh Plate Glass Co., Brush Div., Dept. W-4, 3221 Frederick Ave., Baltimore, Md. Case histories indicate economies available to users of Pittsburgh brushes. Request on company letterhead direct from this company.

Impregnating Microporous Metals. Polyplastex Impregnation Corp., 4 pp, ill. Discusses the use of Polyplastex MC Sealant for impregnating microporous metals to make castings pressure tight. (208)

Plating Baths. Promat Div., Poor & Co., 4 pp, ill. Condensed information on a variety of zinc, cadmium, copper and white alloy plating baths that meet today's metal finishing requirements. (209)

Liquid Honing. Vapor Blast Mfg. Co., 4 pp, ill. Equipment for surface finishing by liquid honing, specifications and dimensions of equipment. (210)

Protective Coating. United Chromium, Inc., 4 pp, ill, No. MC-4. Describes four different groups of Ucilon corrosion resistant coatings, giving properties, advantages and case histories. (211)

Hard Chromium Plating Unit. Ward Leonard Electric Co., 4 pp, ill. Features of Model A-20 Chromaster industrial hard chromium plating unit, description of process and Chromasol solution. (212)

Heat Treating • Heating

Heat Treating Furnaces. A. D. Alpine Inc., 4 pp, ill. Gives features and specifications of six Contro-Therm heat treating furnaces for all types of heat treating, soldering and brazing. (213)

Dissociated Ammonia. Armour & Co., 4 pp, ill. Reprint describes the economic advantages, uses and dissociating equipment used in the employment of dissociated ammonia. (214)

Electric Ovens and Furnaces. Cooley Electric Mfg. Corp., ill. Describes a complete line of electric ovens and furnaces produced by this company. Includes specifications. (215)

Pressed Steel Pots. Eclipse Fuel Engineering Co., 6 pp, ill, No. N-1. Features specifications on a complete line of pressed steel pots for lead, salt cyanide, oil tempering and metal melting. (216)

Film Type Heating Elements. Electrofilm Corp., 12 pp, ill. Applications and characteristics of Electrofilm elements for the heating of metal or nonmetal parts. (217)

Heat Treatment of Aircraft Steel. E. F. Houghton & Co., 4 pp. Explains how hardness and strength of aircraft and other steels can be developed through use of extra high-speed quenching oils such as Hought-Quench "K". (218)

Heat Treating Furnaces. Ipsen Industries Inc., 6 pp, ill. Diagrammatic description of operating principle of Ipsen Series "T" Heat Treating Unit. Includes specifications and applications. (219)

Heat Treating Furnace. Leeds & Northrup Co., 4 pp, ill, No. T-623. Description and specifications of Series H Homocarb Furnace designed for numerous precisely controlled heat treating applications. (220)

Surface Hardening Stainless Steels. Lindberg Steel Treating Co., 24 pp, ill. Complete data on the Malcomizing process for surface hardening stainless steels. Seven case histories are included. (221)

Tubular Furnaces. Marshall Products Co., 4 pp, ill. Discusses both the creep test and tensile test models of Marshall tubular furnaces, as well as control panels and radial brackets. Includes specifications. (222)

Dielectric Heating Equipment. New Rochelle Tool Corp., 4 pp, ill, No. E-11. Features applications and specifications of the Type 15-CH electronic power generator, designed for a wide range of industrial dielectric heating applications. (223)

Hole Quencher. Palmer Mfg. Co., 4 pp, ill. Features advantages of using the I. D. Hole-Quencher for case hardening holes seven times faster. (224)

High Temperature Equipment. Rolock Inc. Catalog gives data on fabricated heat and corrosion resistant alloys for heat treating uses. (225)

Heat Treating Furnaces. The Electric Furnace Co., 4 pp, ill. Shows various gas, oil and electric furnaces for annealing and heat treating requirements and lists applications. (226)

Roller Hearth Furnaces. Drever Co., 8 pp, ill, No. B-90. Profusely illustrates a variety of oil, gas or electrically heated, direct fired or radiant tube roller-hearth furnaces. Includes specifications. (227)

Welding • Joining

Tool Steel Electrodes. Alloy Rods Co., 7 pp, ill, No. AR52-1. General instructions on how to use tool-arc electrodes on the basic types of tool and die steels. (231)

Spot Welding Schedules. Ampco Metal Inc. Reference chart gives recommended schedules for spot welding low carbon steels. (232)

Stainless Fastenings. Anti-Corrosive Metal Products Co., Inc., 80 pp. Catalog indexes and prices of over 7000 varieties of stainless steel screws, bolts and other fasteners. (233)

Fastening Pins. C. E. M. Co., 4 pp, ill. Advantages and examples of how Spirol Pins overcome the inherent short-comings of fastening pins due to their spiral cross-section. (234)

Screws with Integral Washer. Continental Screw Co., 6 pp, ill. Metal and plastic applications of a screw with the lock washer an integral part of screw head. (235)

Solders and Fluxes. Division Lead Co., 2 pp, No. PF132. Descriptions of a variety of Divco transistor solders and fluxes produced by this company. (236)

Explosive Rivets. E. I. du Pont de Nemours & Co. (Inc.), Explosive Dept., 39 pp, ill, No. A-2785. Gives sizes, installation and variety of uses of du Pont's explosive rivets. (237)

Gas Heating Units. Gas Appliance Service Inc., 4 pp, ill, No. 511. Shows various types of conveyor and turntable-type heating units for volume brazing, soldering, annealing and hardening. (239)

Silver Brazing Alloys. Goldsmith Bros. Smelting and Refining Co., 25 pp, ill. Data sheets on silver brazing alloys include sizes, price, shipment and assortments. Also contains list of typical applications. (240)

Rivet-Type Fasteners. B. F. Goodrich Co., Rivnut Div. Cardboard "demonstrator" illustrates working principle of Rivnuts, their construction and applications. (241)

High Temperature Fastenings. Aero Div., H. M. Harper Co., 16 pp, ill. Complete list of screws, bolts, nuts and washers of high temperature corrosion resistant alloys and titanium. Includes tables of chemical and mechanical properties. (242)

Lock Washers. Hobbs Mfg. Co., 4 pp, ill, No. 255. Price list of a complete line of Tangle-Proof high carbon steel, stainless steel and silicon and phosphor bronze lock washers. (243)

Blind Lockbolts. Huck Mfg. Co., 1 pp, ill. Lists 10 actual emergency repair applications employed at an air base by using Huck Blind Lockbolts. (244)

Effective Use of Locknuts. Industrial Fasteners Institute, 23 pp, ill. Descriptions and principles of operation of representative types of locknuts. (245)

Solders. Kester Solder Co., 28 pp, ill. Complete analysis of properties and applications of a variety of Flux Core soft solder alloys and soldering fluxes. (246)

Inert-Gas-Welding Torches. Linde Air Products Co., No. 7979. Details and specifications of the newest Heliarc torches for inert gas shielded arc welding. (247)

Brazing Rings. Lucas-Milhaupt Engineering Co., ill. Case history shows advantages of patented, notched-coil, stress-relieved silver alloy brazing and soldering rings. (248)

Spot Welding Aluminum Alloys. P. R. Mallory & Co., Inc., 36 pp, ill. Detailed description of spot welding for aluminum alloys, plus specifications and diagrams. (249)

Mild Steel Electrodes. Metal & Thermit Corp., 14 pp, ill. Complete data on the various Murex mild steel electrodes produced by this company. (250)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on pages 225 or 226

MANUFACTURERS' LITERATURE

Arc Welders. Miller Electric Mfg. Co., 4 pp, ill. A complete line of transformer type welders for all applications of Heliarc processes. (251)

Screws. Russell, Burdsall & Ward Bolt & Nut Co., 8 pp, ill. Presents principles of fastening, advantages and specifications of a complete line of Spin-Lock screws available in hex, pan, truss or flat heads. (252)

Forming • Casting • Molding • Machining

Oxygen Cutting. Air Reduction Sales Co., 15 pp, ill, No. ADR 78. Designed to assist in the development of specifications and procedure control for the proper, economical and accurate casting of various kinds of steel used for defense equipment material. (256)

Wet-Abrasive Cut-off Machine. The Cincinnati Electrical Tool Co., 2 pp. Description, features, alternating and direct current specifications of this wet-abrasive cut-off machine. (257)

Presses. Denison Engineering Co., 16 pp, ill. Features the installation and uses of the Denison hydraulic Multipress. (258)

Mold Heating Units. Improved Paper Machinery Corp., Plastic Molding Machinery Div., 1 p, ill. Specifications and descriptions of Models 1 and 2 mold heating and circulating units. (259)

Electrical Insulations. Johns-Manville, 32 pp, ill, No. EL-40A. Manual on Quinterra and Quinorgo—highly purified asbestos electrical insulations that are pyrolysis-resistant. (260)

Die Casting Machines. Lake Erie Engineering Corp., 6 pp, ill, No. 23-1. Includes specifications of six models of die casting machines for casting nonferrous metals and alloys. (261)

Shell Molding Process. Monsanto Chemical Co., 28 pp, ill, No. 77. Gives definitions, advantages, uses and equipment requirements for the shell molding process. (262)

Precision Metalworking Machines. O'Neil-Irwin Mfg. Co., 32 pp, ill, No. 52-19. Complete data on a variety of Di-Acro precision machines for die-less duplicating. Includes specifications. (263)

Plastics Molding Press. F. J. Stokes Machine Co., 6 pp, ill, No. 511. Design and operational features of compression molding press 726 and transfer molding press 727. Includes specifications. (266)

Stamping Presses. Verson Allsteel Press Co., 16 pp, ill, No. G-52. Presents a complete line of Verson stamping presses, includes specifications. (268)

Tube Mills. The Yoder Co., 65 pp, ill. Pros and cons of operating a tube mill, plus detailed information on the process. Also technical data on standard and other equipment. (269)

Inspection • Testing • Control

Films for Surface Analysis. The Brush Development Co., ill, No. 653. Applications of, and equipment for using Faxfilm for microscopically examining surfaces of various materials. (274)

Pocket Thickness Gage. Ferro Corp. Describes pocket size thickness gage, said to give good accuracy for measuring nonmagnetic coatings on ferrous surfaces. (275)

Temperature Controls. Claude S. Gordon Co., 4 pp, ill. Brief description and advantages of straight line, fully automatic temperature control. (276)

Metal Spectroscope. William J. Hacker & Co., Inc., 3 pp, ill. Gives description, applications and prices of the Steelscope, a metal spectroscope for rapid qualitative and quantitative spectrochemical analysis of steel, iron, etc. (277)

Recorders and Indicators. Minneapolis-Honeywell Regulator Co., Brown Instruments Div., 44 pp, ill, No. 1520. Factual information on ElectroniK recorders and indicators for measuring temperature, pressure, flow, pH, etc. Includes specifications. (278)

Spectrographs. National Spectrographic Laboratories, Inc., 4 pp, ill, No. 300. Description, operating principle and control features of spectrograph units for both quantitative and qualitative analysis. (279)

Metal Hardness Testers. Newage International, Inc., 1 p, ill. Data on the new Ernst Rockwell A, B and C scale and Brinell low and medium range portable metal hardness testers with direct reading of Rockwell 15N scale 70-95. (280)

Thermocouples. Revere Corp. of America, 4 pp, ill. Precision thermocouples of various types and accessory equipment. (281)

Thermocouples. Arklay S. Richards Co., Inc., 16 pp, ill, No. 5. Description, specifications and advantages of this company's thermocouples and thermocouple accessories. Includes information for ordering. (282)

Ultrasonic Testing Apparatus. Sperry Products Inc., ill, No. 50-105. Description, specifications, applications and advantages of Ultrasonic Reflectoscope for nondestructive testing of metals. (283)

Thermocouples. Thermo Electric Co., Inc., No. G. Shows large variety of wire-type thermocouple assemblies available in many sizes. (284)

X-Ray Equipment. Westinghouse Electric Corp. X-Ray Div., 4 pp, ill, No. B-4787. Describes seven types of x-ray equipment for industrial application, and includes advantages. (285)

Hardness Testers. Wilson Mechanical Instrument Co., 44 pp, ill, No. RT-46. Description and features of available Rockwell hardness testers and accessories. Shows operating techniques and principles. (286)

General

Chain and Belt Conveyors. Michigan Steel Casting Co., 8 pp, ill, No. 1-B. Shows Misco rivetless chain conveyors and Woodman belt conveyors for high temperatures. (287)

Sub-Zero Processing Cabinets. Revco, Inc., 2 pp, ill, No. LTS-52. Gives features of sub-zero cabinet designed to maintain constant temperature and minimize heat loss during usage. (288)

Air Handling Equipment. The Spencer Turbine Co., No. 107-C. Data book on this company's equipment for the handling and use of compressed air. (289)

The Last Word

What's New?

Well for one thing the name of this department is new. Not exactly new, for we did use it here for a number of years. Being somewhat cynical, we call your attention to the change. Our cynicism is in the belief that these department names are not burned into your memory, but that they become a subtle part of the magazine which identify but do not signal. At any rate, we wanted to call your attention to some other changes being made, effective in this issue.

Revivals

Most of the changes to which we refer are more in the nature of modernized revivals than brand new departures in our editorial program. However, there is something fresh out of the think-tank. Let's take them in order. In the front pages you will encounter a new feature called "Men of Materials". This 1-page department will feature the opinions of men prominent in the field of engineering materials. We don't intend to eulogize individuals, but we do want to spread their ideas. If it makes for controversy, all the better.

Next—immediately preceding the feature article section—is the revived editorial comment section, retitled "One Point of View". We decided that the time has arrived for us to express our own ideas again. Another revival is an old friend under a new alias. Old-timers among our readers will remember the "Digest" section which ran for many years. Due to popular demand, as the saying goes, we are reviving that department and calling it "Contents Noted". In addition to digesting articles of interest in the United States and foreign publications, the department will also report on new books, papers at technical society meetings, and government reports. We will note their contents and pass the news on to you—hence the name.

That seems to do it, but perhaps those are enough changes for one month. Hope you like them.

Circulation Gems

Every once in a while the letters we send out to bolster our circulation bring back interesting rejoinders. For example, a few years ago an enterprising circulation man started one of his letters with the quote "The best study of man is man" and ascribed the philosophy to William Shakespeare. Some erudite reader bristled when he saw this and returned the letter with this curt notation: "Pope you dope." That put the circulation man in his place. We feel better about a quotation we got in our mail recently. The correspondent after praising our magazine told us he was merely agreeing with an anonymous writer who said, "If you like me or love me—tell me now—for I cannot read my tombstone when I'm dead." No curt note that!

What's Fame?

Perhaps we're sensitive, but it seems that every time one picks up a magazine or newspaper lately he sees something about titanium. Not that we object, you understand; we merely point this out to show that fame, like beauty is only skin deep. Recently one of our editors had the misfortune to browse through a new desk encyclopedia and look up the listing for titanium. It was there all right and said that titanium is used as an alloying element and, in oxide form, as a paint pigment. There was no mention of titanium as a metal. Spoiled our editor's whole day and caused him to lose faith in encyclopedias.

Who Wrote That?

Speaking of reading recalls in us the fact that we recently looked through some back issues of the magazine. Naturally we looked at some of the stuff we wrote at that time. Our reaction then, as always under similar circumstances, was—"Did I write that? It doesn't sound like me." It's peculiar too, that some of the items that seemed devastatingly funny then, now merely evoked a hollow laugh. Apparently it wasn't deathless prose.

The Century Mark

We were remiss last month in not reporting upon a notable achievement. The manual in the December issue was the 100th in that increasingly popular feature series. Today we publish No. 101. We can only hope that the second hundred prove as timely and helpful as the first, of which more than 275,000 reprints have been distributed.

Pretty Sharp

As any good householder who uses safety razors knows, the blades both old and new have hundreds of uses. They scrape paint from windows, sharpen pencils, cut shelf paper, trim callouses, and even remove whiskers. Like many other items once thought to be purely domestic, the razor blade has now taken its place in industry. Now, we are told by Ajax Electric Co., razor blades can be used to determine the condition of a salt bath. Here's how it's done. A blade is heated in the salt bath and then given a water quench. If upon bending, the blade scraps and breaks, the bath is neutral. If the blades bend without breaking, the bath is decarburizing and needs rectification. And that's our helpful hint for today.

T. C. Du Mond
Editor